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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institution of British Foundrymen.

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The Nomenclature of Semi-Steel.

As was expected the appellation "semi-steel" was adversely criticised at the Birmingham Conference, but no substitute which had the slightest chance of general acceptation by the English-speaking nations was put forward. More than a year ago we suggested the coined word "Fontoid," which received kind criticism but no acceptation. Professor Turner suggests "Toughened Cast Iron." Dr. Moldenke's Committee put forward "High-test Cast Iron," and Mr. S. G. Smith alludes to "Steel Alloy."

Professor Turner's suggestion is open to criticism on the ground that other methods and mixtures can also produce a toughened cast iron, for example, electrically-manufactured cast-iron produces a material akin to that made from steel and pig-iron mixtures, which have been cupola-melted. The title, "High-test Cast Iron," is subject to similar criticism, as again no reference is made to the essential factor, which, after all, is in origin the incorporation of steel.

Mr. Smith's suggestion, "Steel Alloy," gives to the mind the same impression as semi-steel, with the exception that the latter phrase may be taken by some people to relate to a 50 per cent. mixture. Our own suggestion, Fontoid, is no worse or not better than any other coined word based on foreign languages. Now that everybody has decided that semi-steel is an unsuitable term, we propose to put forward some of the many factors which exist for its retention, in order that its condemnation does not become parrot-like.

First and foremost, there is the right of common usage—a factor of supreme importance. Secondly, it denotes, when considered as an adjective qualifying the understood word "cast-iron," the indirect cause of the enhanced mechanical properties. That there is much good ground for such treatment is amply demonstrated by reference to metallurgical trade terms, some of which show process origin and some future use. For instance, "basic steel" refers to the process of its production, for steel, *per se*, can never by any stretch of imagination be sometimes acid and sometimes basic. Obviously the word "process" is understood. On the other hand, "basic iron" denotes its suitability for use in basic furnaces. Really, its impurities are acid, since they are removed under a basic slag. Now, semi-steel cast-iron, to give its full title, denotes that a considerable quantity of steel has been used in its manufacture. We see no objection to its use when regarded in this light, especially if preceded by a qualifying figure denoting the percentage of steel, such as 25 per cent. semi-steel cast-iron. We are well aware that standard dictionaries define semi- as a Latin prefix denoting half, but right of common usage, which is a difficult obstacle to surmount, has modified its use to signify "something in between." Thus, when a person is semi-conscious, there are unlimited degrees of consciousness. Semi-washed, semi-bituminous are other illustrations where the implied "half" is very variable. Therefore, it is admissible to qualify and make definite the quantity of steel used in the manufacture of semi-steel cast-iron. It will thus be seen, if only the foundry world can be induced to regard the word semi-steel as an adjective, the major portion of the fabric built up against its use is destroyed. We shall be happy to hear critics use the expression "universally-accepted" instead of the "so-called" term semi-steel. We feel confident that they are only fighting against the inevitable.

Variations in the Mechanical Properties of Metals and Alloys at Low Temperatures.

Messrs. Leon Guillet and Jean Cournot have carried out investigations to determine the Brinell hardness and notch-impact strength of various metals at low temperatures, the tests having been made at + 20 deg. C., — 20 deg. C., — 80 deg. C., and — 190 deg. C. The test-pieces were maintained at these temperatures 15 hours before being tested. The results showed (1) a gradual increase in hardness towards the lower temperatures. (2) That brittleness at lower temperatures is characteristic of ferrite. The greater the quantity of ferrite the more rapidly the notch-impact strength diminishes with the temperature. Nickel and copper do not exhibit these phenomena. Aluminium, on the other hand, appears to become tougher at lower temperatures. Pure austenite rich in nickel also exhibits no brittleness at low temperatures. (3) The pearlitic nickel-steels exhibit at — 190 deg. C. great brittleness, which seems to diminish as the percentage of nickel increases. The test samples recovered their normal properties when kept for 24 hours at + 20 deg. C., after having been kept at —190 deg. C. for 16 hours.

XUM

Specification for Bull-Head Rails.

The British Engineering Standards Association has just issued a revised Specification for bull-head rails (Report No. 9, 1922). This is the second revision of the Specification originally published in 1904, and embodies the alterations which experience has shown to be desirable to meet present-day requirements. The following are some of the more important modifications made:—

Two classes of steel are now included, namely, ordinary carbon and high-carbon steel, and separate chemical analyses are specified for Bessemer and open-hearth steels. The position in the head of the rail from which the drillings and the test pieces for the chemical analyses and tensile tests respectively are to be taken is now defined.

In the falling-weight test the use of crop ends is permitted, and the measurement of permanent set after the first blow has been omitted. The test is required to be carried out on the British standard testing machine, the specification for which is inserted as an Appendix. The height of the drop for B.S. Section No. 90 has been reduced to 18 ft. (5.49 m.).

The range of ultimate tensile strength for ordinary carbon rails, namely, from 40 to 48 tons per sq. in., has been increased to from 42 to 53 tons per sq. in., and a range of tensile strengths for higher carbon rails inserted (46 to 55 tons per sq. in. for acid or basic open-hearth steel, and from 44 to 53 tons per sq. in. for acid Bessemer steel).

The testing procedure before rejection has been set out in detail. Provision is made for ascertaining the weight of the rails during rolling. The mark of the Association is now only intended to indicate that the rail is of British Standard section. An arbitration clause has been included.

The Report gives full-size diagrams of the British Standard rail sections ranging from 60 to 100 lbs. per yard, and the only departure made from the original standards is in the case of the 85-, 90-, and 95-lb. rails, in which the depth of the head has been increased by 1/16 in., 5/64 in., and 1/32 in. respectively, with the object of securing a longer life, a corresponding amount being taken off the bottom in each case in order to preserve the same weight and depth of the rail. To distinguish the revised sections from the older sections, the former have been designated 85R, 90R, and 95R respectively.

Throughout the Specification and on the diagrams approximate metric equivalents of the British measures have been added for the convenience of users in countries in which the metric system has been adopted, but it is clearly laid down that the figures in British measures are to be regarded as the standard.

Copies of the Specification, 1s. 2d. post free, can be obtained from the Association (28 Victoria Street, Westminster, S.W.).

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

National Foundry Competitions.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was very surprised to find that in the coremaking section at the Foundry Trades' Exhibition, only one particular make of core-oil was allowed to be used.

To my mind much valuable information to iron-founders was lost through not having all kinds of core-oils "on tap" for the use of competitors.

The object of the exhibition, as I understand it, was to improve the status of the foundry trade by the exhibition and demonstration of improved appliances and methods of manufacture.

Core-sand mixing is one of the operations of which so very little is known by the average foundryman, and I am amazed that the Committee responsible for the competitions allowed such a golden opportunity of demonstrating the mixing of core-sand with the various core-oils on the market, by experienced coremakers, to slip past them.

In addition to this, the fact that only one core-oil was used, destroyed the value of the competition, as competitors did not have equal chances, the competitor who had experience with the particular core-oil used having an unfair advantage, and I have reason to believe that the results of the competition bear this out. Also, the fact that only one particular brand of core-oil was used suggests either partiality on the part of the Committee or that the core-oil firm concerned, have a good publicity agent, as the particular core-oil has no special advantages, to my mind, over many other core-oils which were advertised at the exhibition.

Another point on which I should like some explanation from the Committee is that one coremaker (A) sent in his application to enter for Class A, Section I, *in the same envelope* as another coremaker (B). Coremaker (B) received his instructions to attend on a certain date, when he competed, but Coremaker (A), who is the best oil-sand coremaker I have ever known, received no communication whatsoever, and consequently did not compete.

Trusting you will give publicity to this letter in your valuable Journal, and enclosing my card.

I am, Sir,

Yours, etc.,

"OLD BILL."

Book Reviews.

CAPSTAN AND AUTOMATIC LATHES, by Philip Gates. Published by Sir Isaac Pitman & Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 2s. 6d. net.

This little book is another of Pitman's Technical Primer Series, and should be useful for pattern makers and, to a lesser extent, foundry foremen, as the author has presented the subject in such a manner as to assist every reader having an interest in the production of interchangeable work. Primarily, of course, it is written for those whose work is actually to set the necessary tools and attend to them when the machines are in motion. The book is very suited for technical schools as a textbook for first- and second-year men.

NOTES ECONOMIQUES D'UN METALLURGISTE (1915-1921), by Camille Cavallier, Forge-master, President of the Nancy Chamber of Commerce. Published by Gauthier-Villars & Company, 55, Quai des Grands Augustins, Paris. Price, 3.50 francs.

This work, which admits of the rough translation of Some Notes on Economics by an Engineer, is based upon a series of notes taken during and after the war relating to economical questions appertaining to French industries, particularly the metallurgical ones.

The author first makes a comparison between French and German industries from the export point of view, after which he deals with the question of the participation of large manufacturers in politics. After a discourse on the relationship of the proprietors of works with capital and labour, the author submits an analysis of the economic crisis under which the world has laboured for the last two years, clearly exposing the causes and pointing out the necessary remedies.

Mr. Cavallier's book will be a real interest to those of our readers possessing a knowledge of French, as it is always interesting to get the "other fellow's" view, especially when it relates to matters which are of direct concern to this country.

THE MILLING OF SAND.—In our issue of May 4, under the above caption, we described and illustrated a new design of wheels suitable for the milling of moulding sand. We now learn that the inventor, Mr. F. Andrews, has been granted a patent (No. 173,438) and that he has confided the manufacturing and selling rights to Messrs. John Barnsley & Sons, Limited, engineers and iron-founders, of Netherton, near Dudley.

Iron Foundry at Hecla Works, Tipton.

Messrs. Nortons (Tividale), Limited, Hecla Works, Tipton, Staffs, had experienced considerable difficulty in obtaining suitable castings to meet the ordinary demands of the works; indeed, this was frequently the factor which determined the time of delivery. To overcome this difficulty, as also to meet the increased demand for castings on account of new developments, the management determined to build a foundry.

The foundry building forms a right-angle to the main shops, into which there are gateway entrances, and on the opposite side is bounded by an arm of the canal, the position securing at the same time ideal facilities for handling the raw material and a completion or a continuity of the works. The foundry building, which is 120 ft. × 40 ft. × 30 ft. high to the eaves, is built of brick, with a glazed roof and a temporary end to facilitate extensions. The floor is served by a 3-ton electric crane, constructed by the Company's staff. The stocking ground adjacent to the canal is served by a 60-ft. electric jib crane, provided with a 2-ton electric magnet. This crane not only handles the material on the stocking ground, but also serves the charging platform for the cupolas, and the sand hopper which is placed above the sand-mixing shop.

FIG. 1. VIEW IN THE MAIN BAY OF THE FOUNDRY.—MESSRS. NORTONS (TIVIDALE), LIMITED, TIPTON.

FIG. 2. A CORNER OF THE FOUNDRY.—MESSRS. NORTONS (TIVIDALE), LIMITED, TIPTON.

The foundry is served by two cupolas with melting capacities of 5 tons and 30 cwts. respectively. Blast

is supplied by Keith-Blackman fans driven by 20-h.p. and 10-H.p. motors; the fan outlets, however, are cross-connected, so that either fan can do duty for either cupola. The charging platform is very liberally proportioned and affords storage for about 100 tons of pig and scrap and 40 tons of coke. The platform is under roof. The sand-shop equipment includes a Britannia sand mixer and a sand grinder, which are driven by belts from a 25-h.p. motor.

Castings are made in green sand, dry sand, and loam. In the main foundry two Adaptable moulding machines are installed, one plain and one turnover, supplemented by a Duncan-Stewart wheel-moulding machine for mouldng gears up to 10 ft. in dia. The drying stove is of an American type 20 ft. × 10 ft. × 8 ft., and side by side with it a second stove 30 ft. × 10 ft. × 8 ft. The stove is of the double-eased type, heated by underground flues and fired from an independent furnace, the flue plates being removable so that the hot air may be short-circuited when desired. A steel stack, part brick-lined, 60 ft. × 3 ft., serves the two stoves. This type of stove has proved very economical in operation, requiring only 4 cwts. of coko mixed with a barrowfull of rough slack for 24 so that the hot air may be short-circuited when desired. serve the stove. The core shop is in an annexe. The benches are a notable feature in this shop, being covered with cast-iron plates with planed surface, thus eliminating the use of separate plates for knocking up. The cores are dried in a coke-fired stove by Ballard & Company, Limited, Tividale, Staffs.

Adjoining the main building is a shop 40 ft. × 26 ft., in which the light castings are made; this shop is furnished with 3 Britannia jar-ramming machines. The fettling shop adjoins this last, and contains the usual equipment of pneumatic chippers, emery grinders, etc., whilst in an annexe is a Britannia compressor which supplies the power to the pneumatic tools, as also the jar ramming machines. In the fettling shop is also a Hodgson and Stead 5-ton weighbridge. The fettling shop has a gateway communication with the yard, and as the crane runways which serve the main machine shop extend over the fettling shop, the castings can be picked up and conveyed direct to the machines or loaded into wagons for direct despatch, as the case may be. The foreman's office is in a mid position, so that he has a clear view of both foundries and fettling shop. As the foundry is for all practical purposes run as an independent works, a separate building has been provided for the foundry manager's office and foundry drawing office. The pattern shop and pattern stores replete with the usual complement of tools, are housed in shops whilst adjacent to the foundry.

In addition to supplying the demands for castings for the works, the foundry is engaged upon the production of general castings for the trade in weights ranging from a few pounds up to 3 tons. At the time of our representative's visit, castings were being made of moulds for rubber tyres, special sections of pipes and parts for gasworks and by-product plants, etc. A new line with the Company is the manufacture of pit sheaves, the first of which, 14 ft. in dia., was on the floor.

THE LATE Mr. R. Hardy, of Swansea, chairman of R. Hardy & Company, Limited, metal merchants, left £10,088.

THE LATE Sir John Scott, Bt., who died on April 29, left a fortune of £582,165, the net personalty being £563,034.

The Structure of Coke.—Messrs. H. D. Greenwood and J. W. Cobb, in a Paper on this subject read at the Yorkshire Section of the Society of Chemical Industry, thus summarised it. The formation of high-temperature coke can be divided into three stages:—(1) The first stage up to 550 deg. C. is constituted by the initial cell formation, the cells having relatively thick walls of soft material of low specific gravity, the process being accompanied by a swelling of the charge. (2) Between 550 and 850 deg. C. the mass as a whole shrinks, and an increase in specific gravity of the coke material ensues, the resulting coke having thinner but stronger walls and the porosity reaching a maximum. (3) In the last stage the predominant factor is a further large contraction of the mass as a whole, the coke material undergoing no appreciable increase in specific gravity. We are thus left with a strong coke, constituted of small pores with relatively thick walls. At no stage in coking to 1,100 deg. C. does the material approximate to the specific gravity of graphite, 2.3. The authors have followed the process in a fairly typical gas coal, but believe that its essential features would be reproduced in the behaviour of coking coals generally. The swelling of the coal in the first stages of carbonisation is well known to cause difficulties in withdrawing coke made at low temperatures, and in producing sticking at the top of the charge in continuous vertical retorts and gas producers, particularly when fitted with a bell.

Die Castings and Alloys for Fine Mechanics.

When the use of alloys, both of the heavy metals, lead, tin, and zinc, and of light metals, for making finished castings of parts of meters and of other instruments, was discussed at Berlin in connection with a Paper by K. Kaufmann, of the Fertig-Guss Gesellschaft (*Zeitschrift für Metallkunde*, January last, pages 8 to 22), so many admissions of troubles with these castings were made by the lecturer, as well as by other manufacturers and professors, that one might feel doubtful as to the reliability of these alloys, some of which were "war substitutes." The discussion dealt in particular with die-casting prepared by forcing the fused alloy by a piston through a hole into the metal mould. But sand castings of the same alloys are also in use, and some of the "Spritzgusslegirungen" are undoubtedly promising. Thus the ample analytical detail of the various alloys given during the discussion will be of considerable interest.

The long-known castings of tin-lead alloys are not strong, have low melting points, and must not be heated above 100 deg. C. subsequently, but they shrink little and keep their exact dimensions. Pure zinc is not suitable; alloyed with tin, or with copper or aluminium, it answers; but tin and aluminium do not go together in general; tin foil containing more than 0.2 per cent. of aluminium may crumble in a few days; in complex alloys of zinc and aluminium the influence of tin is less clear. Zinc-tin alloys (for the mouthpieces and horns of telephone apparatus) should not be varnished at temperatures above 150 deg. C., lest a tin alloy sweat out in beads. The Siemens Company exhibited a great many specimens of alloys, essentially of zinc-aluminium, both sand and chilled castings, which had failed, cracked, expanded, or shrunk, and had become distorted. The Al percentages varied between 2 and 70 in these products, which contained also copper, lead, and sometimes tin. It was mentioned that in America the use of alloys of Al-Zn with medium Al-percentages had been abandoned by some firms. Some new alloys are treated with acids to produce a fairly non-corrodible surface. Ageing processes are advisable, and purchasers should receive full instructions as to the use, and be informed also as to the date when the goods were cast and after what period they might safely be mounted. That, of course, might preclude the utilisation of hastily-ordered parts. One zinc alloy containing 4 per cent. of copper, 1 per cent. of aluminium, and 8 per cent. of tin, and particularly the new durolith, the composition of which was not stated, were said to give full satisfaction as to strength, hardness, and constancy of dimensions.—"Engineering."

European v. American Moulding Machine Practice.*

BY E. RONCERAY of Ph. Bonvillain and E. RONCERAY, Paris.

The object of this Paper is to point out by a European the relative advantages and disadvantages of the European Moulding Machines compared to the standard American machines. The author points out the relatively small use of compressed air as a motive power in European machines and the large percentages of machines which are designed to use hydraulic pressure. The reason being given that compressed air can be used only for small moulds when using pressure machines, while water pressure on the other hand utilises pressures from 750 to 1,500 lbs. per sq. in. A detailed comparison of the two power mediums follows: It is stated that it is quite usual in European practice to work 20 moulding machines at full output with a 5 h.p. pump, the main pipe being ¾ in. inside diameter. Water pressure is stated to show a definite superiority over compressed air for machine moulding, particularly in countries where coal economy is acute.

SIR CHARLES PARSONS has had the degree of Doctor of Engineering conferred upon him by the Sheffield University.

*Abstract of a Paper presented before the American Foundrymen's Association Rochester Meeting.

Discussions on the Birmingham Conference Papers.

SEMI-STEEL.

Introducing his Paper, MR. CAMERON said the results were far better than expected with regard to the test bars. That there were only two failures was very surprising, and the material turned out day after day gave satisfaction to the people who were using it. He must say that they had the unique experience in this work of having the hearty co-operation of every man, woman, and child in the place. He also acknowledged the great help he had received from Mr. McLain, Prof. Campion, ex-President Riddell, Mr. Fletcher for his valuable addition, and Mr. Shaw for his practical aid when Assistant Director at the Ministry of Munitions.

MR. S. FLAGG (United States) opened the discussion by asking whether in conjunction with the cupola the lecturer used a mixer or receiver.

Tensile Test for Cast Iron Unsuitable.

MONS. E. RONCERAY (Paris) referred to certain tests mentioned in the Paper for which he appeared to be in some way responsible, but several tests had been taken, and those tests had been found entirely wrong; some of the worst tests gave good tensile results and some of the best tests gave the reverse. The tensile test was not fit for cast iron, but he fancied that the tests made in France were more reliable. He thought what Mr. Keep had done was wonderful. Mr. Keep, he believed, had, in America, made several thousand tests of high silicon iron, and while on this point he might say that his own experience was that an amount of silicon between 2 and 3 per cent. did not appreciably change the strength of the metal. He had used 3.25 to 3.50 per cent. and had not found any trouble. It was an interesting problem to find out whether more silicon than that would do any harm. He did not think it advisable always to use it, but in the case of large and small castings it would be useful to know the differences that resulted, and that they could safely put more silicon into the latter.

Size of Test-Bar Important.

MR. J. SHAW: We are indebted to Mr. Cameron for putting before us the methods employed by his firm in attaining the reputation they have in making various castings in semi-steel. There are three points on which I would like to have further information. One of the chief claims for semi-steel is the small size and fine distribution of the graphitic carbon, this property making the metal so useful to resist pressure. In view of this fact, one would not expect a drop of about 3 tons when the tensile bar was increased from $\frac{5}{8}$ to 1 sq. in., turned down to 0.564 in. In this respect it would seem to be little better than ordinary iron. I note, however, the American Radiator Company put forward tests up to 21 tons on a bar cast $1\frac{1}{4}$ in. dia., turned down to 1.128 in. dia. The mixture was made up of, roughly, $\frac{1}{3}$ steel, $\frac{1}{3}$ pig, $\frac{1}{3}$ remelt, and the analysis was TC, 3.02; GC, 2.36; CC, 0.66; Si, 1.28; S, 0.123; P, 0.104; and Mn, 0.6 per cent. It must be remembered that most of the tests mentioned by Mr. Cameron were made on the 5-16-in. bar.

Low Sulphur Queried.

The second point noted was the very low S obtained by Mr. Cameron. To keep the S down to even 0.058, his maximum figure, denotes practice not usually attained. When it is remembered that the gain of S in good cupola practice is about 0.035 per cent., add to this the effect of extra fuel often used and the greediness of steel in a red-hot pasty condition to absorb S, it is remarkable. From some hundreds of tests taken at one prominent firm the average S was 0.112 per cent. This is round about the figure mentioned in the Paper as being obtained by other workers.

A Carbon Absorption Query.

Mr. Cameron, on page 498, gives details of several experiments that tend to show how little C is absorbed during the melting stage. On the other hand, it is difficult to understand when it can be picked up afterwards, when we remember cupolas, with tuyeres as low as possible, running all day and hardly ever botted up, the metal running into a large receiving ladle. There can be practically no contact with the bed in this case once the metal is melted. Yet the lowest recorded in that works was 2.81 per cent. The only record of a low TC that I know of was one mentioned in the January issue of THE FOUNDRY, where a firm using 50 per cent. steel, with the remaining half made up of an 8 per cent. ferro-silicon with 2 per cent. C. This metal was stated to get down to about 1.8 per cent. carbon in the middle of the blow, with 3 per cent. at the start.

High Phosphorus Considerations.

MR. H. FIELD (Birmingham) described the Paper as excellent. There was a tremendous future for this high tensile metal—so-called semi-steel. Alluding to Mr. Fletcher's comments, he believed that gentleman recommended them to make a high steel mixture of 50 per cent. steel, perhaps, and to use it in further work for the purpose of making a low steel mixture. That would seem to suggest that the whole of the beneficial properties of this material was retained on constant melting. He would like Mr. Cameron to confirm or otherwise as to whether, when a semi-steel mixture was constantly remelted, it retained the properties which it had originally. He quite agreed with the lecturer as to the necessity for a high melting temperature, and the very great possibility of getting chilled metal if they were not extremely careful in this respect. This metal was much more prone to chill than ordinary cast iron of apparently similar analysis. But on one point he was not in agreement with Mr. Cameron, and he said this for the encouragement of any member who was thinking of launching out in the use of this mixture. Excellent results could be obtained with a high phosphorus metal; he had worked considerably with mixtures of this kind, and there was in his experience very little difference except in one particular between the high and the low phosphorus metals. That one difference was in regard to the transverse test. But if one wanted a high tensile strength with 1.5 per cent. phosphorus in a $\frac{3}{4}$-in. bar it was an easy matter to get 18 to 19 tons tensile. On transverse tests certainly high phosphorus metal did not give such good results. However, if one required a close grain, which was one of the principal purposes of making this mixture, high phosphorus metal gave it equally as well as low.

Properties of Remelted Semi-Steel.

PROFESSOR TURNER (Birmingham) said they all felt how important the subject was. He was interested in the comments of Mons. Ronceray in reference to the proportion of silicon which was recorded by the experiments in 1885. It was definitely stated in that Paper that the conclusions related only to material of a certain composition and cast a certain size, and that fact was sometimes omitted. He was very pleased to hear the references to Mr. Keep and his work. It was his pleasure to have had him as a personal friend for a number of years, and his work in relation to silicon in cast iron was of the very highest value. The question had been raised as to the name which they should give to this material. He did not know a better name than that originally given to it by Sterling 80 years ago when he introduced this metal; he called it toughened cast iron. He made it by mixing wrought iron with cast iron, and then combining it with a certain amount of pig-iron. As to the question raised how far the properties of the metal would be retained on repeated melting, he did not think they would be retained. He suggested an explanation years ago in a discussion on the mixing of two different kinds of iron. They found with varying silicon properties which did not correspond with the chemical analysis. He suggested that the beneficial effect in the one case was due to the precipitation of the carbon in matter and form; he used then the language of the time. He should say now that it was due to the precipitation of the carbon—graphitic carbon—in the solid material. It produced a fine state of division, and did not have that brittleness and weakness which they associated with larger

XUM

flakes. The question of the proportion of silicon was not so important as that of the amount and character of the carbon. Silicon, sulphur, and phosphorus, and so forth, produced a certain balance, and it was the net result with which they were concerned. They wanted first of all the maximum amount of combined carbon the material would contain or sustain without having free cementite. So far as carbon was concerned, they wanted as much as it would stand, and the amount it would stand depended on the quantity of silicon and other elements. The next thing required was that the carbon should be of the right total quantity; it must not be too high, and it must be in the finest possible state of division which they could obtain. If they could get those things together then they obtained the best quality of iron. He thought the Paper was a valuable contribution which they should read with pleasure, not only immediately after the conference, but for years to come.

Type of Pig-Iron Important.

Mr. J. E. Fletcher (Dudley), speaking of the total carbon in the use of various kinds of pig-iron in mixture, said he thought they had some very valuable suggestions in the Paper. Those who had made semi-steel were constantly finding that the type of iron being used was of the highest importance. Mr. Cameron, in mentioning the suitability of high-carbon irons, said they might with advantage use those high in manganese, and referred to hematite irons and steel scrap generally as giving good results. Their American friends were using that type of high-carbon irons and were reaping the advantage. The remarks of the lecturer about the efficiency of the Scotch type of irons corresponded with his own experience, which was that they gave remarkably good results. His own experience in trying to mix steel scrap with cold blast iron with a low carbon content was that the results were very disappointing. He thought the whole thing seemed to point to the fact that the iron is carburised more efficiently when they had iron of a fairly high carbon of the hematite type.

Mr. F. J. Cook (Birmingham) said he would like to draw attention to one paragraph of general interest in regard to obtaining better tests by using high-class irons, including cold blast, special brands and special cylinder pigs. He had been using semi-steel and high-class cylinder irons for the last 15 years, and he could confirm what the lecturer had to say in respect of the bad effects on the tensile strength of the metal. But in dealing with Diesel engine work and liners for high superheated steam he had found a distinct advantage in the wearing properties of the metal which seemed to counterbalance the loss in strength.

Application of Semi-Steel.

Mr. Young (Newcastle) said that Mr. Cameron's paper was one that they had all been waiting for over a long period, and it could scarcely have been placed before them more lucidly. However, he considered care needed to be taken as to how they applied this so-called semi-steel. He did not think it was universally applicable to any and every casting, and as Mr. Shaw had hinted, the thickness of a casting was of very great importance as well as silicon. Going into the exhibition recently he was tackled internationally upon this semi-steel question, but he must confess that he only used it when he wanted it, and one did not want it always. The author had referred to the effect of sulphur, and gave two analyses, and stated that good metal could not be made with the amount of sulphur shown. If they looked back through the paper they would find another analysis contained a low sulphur and high manganese, but here when condemning sulphur there was no manganese. He thought the fault in this iron was with the manganese, not with the sulphur; and generally they could not make good cast iron with a low manganese content.

Melting Troubles.

Professor Campion, in his remarks, said that haphazard, unorthodox methods did not give proper results; everything must be carefully measured and weighed. The early troubles of semi-steel were not due to the steel not melting readily; indeed, it melted easily, and generally melted before pig-iron. If this point was carefully attended to, there should not be the slightest difficulty in getting a good, strong metal. On the question of the size of test bars, the casting thickness made a large difference to the strength and property of the metal. They had recently cast 1½-in. bars cut down to 1.1 in., with a strength of 18 to 20 tons.

THE AUTHOR'S REPLY.

Mr. Cameron, in reply, answering Mr. Flagg, said they had not used a receiver. They used an ordinary cupola. With a mixing ladle they could take every charge by itself, which would be impossibls with a receiver. Regarding Mons. Ronceray's remarks, which were always interesting, he agreed that some of the tests and analyses given by Government departments were, to put it mildly, capable of improvement. He was pleased to hear from Prof. Turner and Mons. Ronceray that a high silicon content was not the dreadful thing that some of the ironfounders rather thought it was. As to Mr. Field's question whether semi-steel retained its properties after remelting, he believed some firms were using refined iron by a process of putting large quantities of steel chain into the blast furnaces. The practice of melting semi-steel mixtures in the cupola and remelting it had been followed with very good results, but probably if it was remelted too frequently it would deteriorate, as Prof. Turner said, and the sulphur would be absorbed. But to a limited extent remelting was useful in his experience. No doubt Prof. Turner's remarks about cast iron would go to the proper quarters. Turning to Mr. Fletcher's comments, he wished to emphasise that in 1918 ironfounders took whatever iron they could get; they were not allowed to use hematite. The great difficulty was that it was practically impossible to work to a uniform analysis; the chief thing being to produce these munitions at the necessary tensile strength, which was the Government test, and, he might also say, the ultimate test of these castings was fragmentation, as to which this metal gave excellent results. The Scotch irons used worked beautifully with steel scrap. Commenting on Prof. Campion's remarks, he hoped in the near future to make some real systematic research in regard to this material, particularly with respect to the relation of carbon to silicon, and so forth.

A Written Opinion.

Mr. S. G. Smith, in a written contribution, congratulated Mr. J. Cameron upon the very ablo Paper dealing with added mild steel to grey cast-iron mixtures, and stated that the use of such mixtures is by no means modern. It is just 48 years ago during his foundry apprenticeship that his firm poured such castings as guides for wire mills and guide plates for small merchant mills. These castings were subject to very high frictional wear, and if made from ordinary cast-iron mixtures as was then used their life of service was very short indeed. The steel in the form of rail ends, plate scrap, etc., was put into the cupola with the last charges of metal. No record of percentages was kept at that time, as foundrymen in those days did things and said nothing, and he still had great admiration for foundrymen who were elderly when he was a boy for what was accomplished by them.

Mr. Cameron's opening statement truly says that the appellation " semi-steel ' is misleading. He agreed with him. It is high time that this product should have a suitable name and specification. Text-books infer that iron containing more than 2 per cent. carbon is cast iron. The unsuitability of the name semi-steel brought an incident to his mind which occurred about five years ago. The engineers in a large engine-building concern, who had heard, or read, something about semi-steel being a good materal for resisting to superheated steam, inquired what should be the analysis of semi-steel. Without giving a thought for what purpose this was required, the analysis given was based upon the percentages of constituents of an average steel, and an average foundry iron put together and halved.

Shortly afterwards, a specification came from the engineers' office to the foundry that the analysis of certain castings must comply with the specification, which gave the total carbon a little above 2 per cent. Nothing more need be said, as it is common knowledge that it is very rare,

regardless of percentages of steel put through a cupola, that total carbon will be less than 3 per cent.—more often it is well above that figure.

Whilst Mr. Cameron states that semi-steel does not displace steel or malleable cast iron, he thought there may be exceptions to this. There is a mixture of cast iron called "steel-alloy"—a much better name than "semi-steel." He knew of castings which were formerly made in steel and are now made in steel-alloy, the results being most favourable in every way. The castings referred to are comparatively thin—about half-inch section, and pass through an annealing process.

In the Paper it is stated that semi-steel is much superior to grey iron for machining. To this he could not agree. His experience with many mixtures of cast iron was that castings poured into iron permanent moulds (when not chilled) gives a perfect surface, regardless of the fineness of the thread. Also, this perfect surface can be obtained from suitable mixtures of cast iron not poured into permanent moulds. Additionally, a claim is quoted that semi-steel is a self-lubricating metal. This, he thought, was too good to be true. The quality of self-lubricating is more probable in castings containing a high total carbon, say 4 per cent., and a low combined carbon, say 0.04 per cent.

On page 497 the author states that semi-steel does not owe its qualities to chemical analysis so much as its physical structure. Surely Mr. Cameron will agree that those remarks apply to most mixtures of cast iron equally as well as steel-added mixtures.

Regarding the tests, he hoped that foundrymen were not making a lash to be whipped with. It is not often that the physical qualities of a test-bar clearly indicate the suitability of metal for castings they are supposed to represent. He would like to enlarge a little upon this aspect, but as the matter is now under consideration, and that he was serving on a branch committee, he did not propose to pursue the matter at present.

On page 498 reference was made to a bar cast from white iron and steel scrap being twisted after prolonged heating. He thought this was quite common in malleable-iron foundries.

The information given upon cupola practice he was quite in agreement with. Strange to say, the matter coincides in a remarkable way with an article prepared by myself upon that subject for THE FOUNDRY TRADE JOURNAL, and appeared in that paper twelve years ago.

The following are four results taken from numerous mixtures of cast iron and steel.

Mixture No. 7.—Steel 90 per cent., and No. 3 hematite pig 10 per cent. This gave a metal of the following analysis:—

C.C., 3.98; Gr.C., nil; Si., 0.13; Mn., 0.45; P., 0.034; and S., 0.171 per cent. The diameter of the cupola was 72 in. The steel scrap was composed of borings, turnings, billet ends, and miscellaneous material. The fracture was white.

No. 2 Mixture.—Cold-blast iron, 25 per cent.; No. 3 foundry pig, 25 per cent.; foundry scrap, 25 per cent.; and steel shells, 25 per cent.

On analysis this mixture gave C.C., 0.705; Gr.C., 2.80; Si., 2.031; Mn., 0.62; P., 0.23; and S., 0.124 per cent.

The transverse test gave 3,430 lbs. breaking load associated with a deflection of 0.09 in., whilst the tensile test registered 8.84 tons per sq. in. In this case the diameter of cupola was 60 in.

The object of this test was to attempt to minimise the growth and pitting in castings due to impinging of superheated steam. It should be pointed out that the low tensile test was probably due to the addition of steel to a strong iron, however the material was suitable for the purpose desired.

Nos. 3 and 4 Mixtures.—No. 3 foundry pig, 50 per cent.; steel scrap, 50 per cent. In this case the analyses were respectively: C.C., 1.58; Gr.C., 1.45; Si., 1.29; Mn., 0.36; P., 0.89; and S., 0.25 per cent. for No. 3, and C.C., 0.61; Gr.C., 2.70; Si., 1.90; Mn., 0.56; P., 1.05; and S., 0.13 per cent. for No. 4. Seventeen and eighteen tons per sq. in. were registered by Nos. 3 and 4 respectively, whilst the fracture of the former was steely and the latter dense.

Of course, castings from No. 3 mixture would be unmachinable, due to high sulphur, which influenced the combined carbon to rise to 1.85 per cent., caused probably by faulty cupola operation and condition.

Economy in steel mixtures will depend upon the price and availability of suitable steel scrap.

He thought no doubt existed that the addition of steel scrap strengthens denseness and toughens a soft, weak pig-iron; yet it should not be considered that for all practical purposes satisfactory results cannot be obtained without the addition of steel scrap. It has been shown many times that these results can be obtained with pig-iron mixtures without the use of steel scrap.

THE HISTORY OF LOAM MOULDING IN THE LIEGE DISTRICT.

DR. LONGMUIR, having thanked M. Varlet for his Paper, said he supported all the statements made therein with the exception of the statement that loam moulding was introduced in 1846. Throughout the whole of mediæval Europe and mediæval England loam moulding was in use. Prof. Turner, in his "Metallurgy of Iron," referred to the first cast-iron made in Sussex. The early Sussex ironfounders were in all probability loam moulders.

Apprenticeship Problems.

MR. GALLON (Newcastle) said in England they would be glad if they could get such boys to train as M. Varlet portrayed in his Paper, boys who would take an interest in the principles of machine construction and pattern-making, and then in moulding. They had not had such boys in this country. It would be their greatest pleasure to teach such boys all they possibly could. In England boys were put into one of the different branches of the trade, therefore they could not teach them now as M. Varlet would have them taught. He did not know a boy in the whole of England who could design a casting. He meant a young fellow who was brought into the foundry to learn the trade. He did not know one such that was taught to design a casting from the very beginning. He took notice, as he read the paper, that the men of Liege were not afraid to work. They could turn this great big slag ladle out in 18 hours. He would be glad to see it done in that time in this country. He did not know whether they worked 10 hours a day in Liege, but if they worked 8 hours it would be a very difficult thing to do the job in three days. M. Varlet described the chiselling of the centre hole out of a plate for the centre pin to work upon. He (Mr. Gallon) would like to ask if that was not a mistake. Forty-five years ago, when he was an apprentice, they used to cast those centre holes in the plate. They secured a pin vertically in the sand bed, and cast the plate around it. He considered that was very much better than boring a centre hole into the cast-iron plate. He would like to hear something as to other methods of casting cylinders. The Paper appeared to him to be a great one, and the greatness of it was its simplicity and honesty; it conveyed something they could carry away.

MR. YOUNG said he thought every foundryman attending the Conference ought to go to the Birmingham Technical School. They had not anything like it in Newcastle. He thought if other institutions went on the same lines as the Birmingham Technical School they would get the educated boy they wanted.

MR. WILKINSON congratulated M. Varlet on the excellence of his Paper and the clearness of his drawings. He (Mr. Wilkinson) totally disagreed with Mr. Gallon's remarks. It was quite possible to get young men in England to take a keen interest in their work. Personally he could recall several who came under his own charge. Showing a little aptitude for the work they were taken in hand, and they made very rapid strides. He coached one or two in the laboratory, and he was very much surprised by the interest they took in their work. He knew from personal experience that lads in the South of England, in the North and in the Midlands would take a keen interest in the work if there was the human touch to encourage them. If they tried to get at the lads on their own level a good percentage of them would try to use their brains as well as their hands. They must do a great deal more to encourage brain work among the youths in their foundries. Unless

they very carefully trained the youths to follow in their predecessors' steps and improve on their often defective work, they could not hope to hold the position they had hitherto held. It seemed to him the human side was being applied to the problem in Liege with very considerable success.

THE PRESIDENT said M. Varlet would have an oportunity of seeing the discussion after it had been translated into French, and his reply would be published in due course.

A Written Opinion.

MR. S. G. SMITH, in a written contribution, stated that Mr. Varlet's historical notes upon the loam moulder are interesting. On column, page 473, Mr. Varlet refers to an early period of loam moulding, when the cost of production was lower by that method than in the case of the same castings made in sand, adding that to-day the contrary would be the case. Personally he did not altogether agree; so much, if not all, depends upon the way adopted, outlay, tackle, etc. There are expensive and economical ways of loam moulding.

A few years prior to the war he (Mr. Smith) produced plain repetition loam work as low as 7s. 6d. per ton, 54-in. 60-in., and 66-in. socket and spigot pipes 9 ft. 6 in. long for 10s. per ton, 40-in. and 50-in. dia. double flange Gee pipes 9 ft. 6 in. long for 12s. 6d. per ton. Internal flange cylinders 4 ft. to 8 ft. diam., and from 4 ft. to 8 ft. long, were made regularly for 20s. per ton. A medium size of the latter, three men would make one casting in two days. The above compares favourably with Mr. Varlet's figures which he gives later on in the paper.

On page 474, column 1, under the sub-heading of "Loam Mixture," the tannery waste referred to is, I assume, cow-hair?

"Sand Mixtures No. 1," consisting of new sand and horse manure, would be a rather extravagant mixture. Why not some floor sand?

On page 474, column 2, the maximum labour given for slag pan is given as 18 hours. Does this include both skilled and unskilled labour?

Page 475, Fig. No. 3, deals with a fly-wheel. He (Mr. Smith) did not think that the best method is adopted for making these wheels. Forty-five years ago we used to strike the outside of the rim up in loam, the arms were formed in dry sand cores, the rim and hub were covered with loam plates.

He had made fly and grooved rope wheels various ways, but the cleanest, quickest, and most economical way is to make and assemble the whole in dry sand cores. Such wheels, or half-wheels of any diameter or weight can be made in the minimum time and cost. A brief reference to this method and procedure appeared in THE FOUNDRY TRADE JOURNAL, May 25, 1922, in which a fly-wheel problem was dealt with.

On page 476, Fig. 4, calender cylinders are dealt with. This is a very plain external-flange cylinder. No provision appears to be made for the dross head, which he thought is necessary to obtain a clear top flange. The method adopted in making this casting involves breaking-up the brickwork for each cylinder.

If this is a repetition job it can be obviated by making suitable tackle. He (Mr. Smith) had given a full detailed description of method and procedure of making external flange cylinders without removing the brickwork, or rather, without breaking up the outside brickwork. This appeared in THE FOUNDRY TRADE JOURNAL about 1913. Mr. Varlet will find this a most economical method of producing such castings. Upwards of 50 cylinders can be made without re-bricking, or, ramming the outside of the mould.

This contribution will be unduly long if reference is made to other castings in the Paper. It is an open question regarding the superiority in skill of the loam or sand moulder. It is said that moulders, like poets, are born, not made. There is little in common with the methods of the two, and a combination of both is like the old-time fitter, very rare.

A loam moulder's daily routine is with spindles, plates, bricks, strickles, etc. A sand moulder's daily routine is with various kinds of patterns, borers, rammers, etc., to which he has to apply his intelligence as well as his weight.

The risks of the sand moulder regarding faulty work is greater than the loam moulders.

THE MANUFACTURE OF LIGHT STEEL CASTINGS.

MR. BRADLEY emphasised, in introducing his Paper, that he was speaking from a jobbing steel-founder's standpoint, dealing with the sand problem and pouring temperature, and with obtaining a good, sound composition. He contrasted the different requirements for repetition as distinct from jobbing work, pointing out that in the latter case it was more difficult to make good steel castings, and remarking that it was essential they should have machines for doing certain classes of repetition work.

Research on Sand Necessary.

MR. F. MELMOUTH (Braintree) observed that an enormous amount of metallurgical investigation had been expended on steel production, and they had to admit that their knowledge of steel was infinitely greater than their knowledge of sand. It was a simple matter to turn out steel perfectly suitable for light castings, but it was more difficult to turn out suitable light steel castings. After the steel left the furnace it was subject to various influences of either incorrect methods of casting, speeds of casting, or incorrect sand. As to the card system, he thought it was in operation in every modern foundry, but the point he had noticed was that it appeared to be very often overdone, and in some cases the card system cost nearly as much as the casting. The runner bushes should be about the same height, so that the ladles would not have to be raised or lowered. Light steel castings as a production article were usually made in the mass production shop. With regard to the point of putting green sand castings nearer the source of the steel because they were lighter sections, in America the conviction was that light castings required drying more than the heavier type; that was, within reasonable limits. He had carried out a great deal of work on light castings, and he was rather coming round to that way of thinking. Mr. Bradley had mentioned electric welding, and there was no doubt, electric welding was considerably cheaper than acetylene welding. Had the author found out any appreciable difference in fluidity in the manufacture of steel castings by the pneumatic processes as compared with the electric furnace. He appreciated the remarks on design, and said that they would secure cheaper and better castings if the designer would consult the foundryman before he made his design.

Temperature Queries.

MR. DARBY asked what was the correct casting temperature, seeing that the speaker alluded to the difference it made in the casting. He found that he could not definitely ascertain what the correct temperature was. The reason why steel was more difficult to handle than cast-iron was because of contraction. Mr. Bradley did not give any idea of what temperature he annealed the castings, and he would like to know whether he annealed all small steel castings, because with different carbons they required different temperatures for annealing.

MR. WILKINSON said the whole question was an extensive one, and one hardly knew where to begin to discuss it. As to the pouring temperature, there was only one, and that was the highest at which they could get the metal. He said this without any reservation whatever from long experience, and obtained castings entirely free from cracks. Cracks occurred during the setting or freezing of the metal, he said in describing an experiment in which the metal was poured at different temperatures and the mould was altered so that the casting contracted in the sand. He advised that moulds should be constructed so that contraction could properly take place. Anyone having trouble with light steel castings, he recommended that they should cast them with a small gate and make the mould so as to allow for contraction; good results would follow. In his opinion there would be no light steel castings in green sand moulds in future years. But he should not care to trust three to four tons of steel in green sand moulds. It was cheaper to make a dry sand mould than a green one, and there was the advantage of the element of safety in the dry sand mould which was entirely absent in the green sand. If it came to a question of which was the best green sand, it was possible to make sand mixtures with almost any ordinary ironfounders' sand that

would give moderately successful surfaces on green sand castings. Where most foundrymen went wrong on green sand was in making it too damp. The difficulty was to work the sand well on the dry side, yet sufficiently strong to resist the metal, but it was possible to get sand with a fair amount of bond and yet dry enough to perform its function properly.

Temperature Variations from Bottom Pouring Ladles.

MR. FAULKNER, after thanking the lecturer, remarked that in discussing the question of light steel castings they were up against a difficult proposition. With the exception of a few leading firms, they were much behind their Continental competitors. And some of the less-known metallurgical countries knew more about light steel castings than they did; indeed, he believed, the best steel castings were made in Italy, with Switzerland a good second.

With reference to the casting temperature it should be pointed out that the first drop of metal out of a bottom-pouring ladle having been in direct contact with the bottom of the ladle would be cold. The metal following would be hotter, being drawn from the body of the ladle until such time as the "time factor" began seriously to operate. The fluidity of electric steel had been adversely criticised, due, no doubt, to the fact that operators used to handling tool steel had been called upon to make steel for castings, and contrived to give to this metal the same "deadness" as that necessary for tool steel. This, the speaker affirmed, is not necessary, for, according to Dr. Desch, exceptional deadness eliminates all exothermic reactions such as one associates with steel made by the older processes.

Sand Moulds Discussed.

MR. HARLEY (Coventry) remarked that he had been concerned with light steel castings in enormous quantities for the past twelve or fourteen years, ranging from 1 oz. to 3 cwt. One speaker had said no green sand steel moulds would be made, and he was not sure whether to support that or not. He had made hundreds of thousands of light steel castings, including lorry wheels, and they had cast these lorry wheels in green sand entirely and with satisfactory results; in fact, they had never had a steel lorry wheel returned. That would prove that there was not much wrong with the method of manufacture. In theory casting in green sand was the best. In his opinion a great deal of the trouble in making steel castings arose from casting them in dry sand moulds. In weights such as he had given there was, perhaps, no choice in the matter, and up to those weights he certainly should not advocate dry sand. They had sufficient to contend with in the "pulling" of mild steel, which had abnormal contraction compared with cast steel; but they intensified their difficulties by utilising hard, resistant dry-sand moulds. They must so design their patterns, and must help that by having a soft, unresisting sand mould, to allow the natural contraction to take place. If contraction took place to the full extent, then they would not have the annoying trouble of cracking. When they started on road wheels they went into this matter and they allowed too little, because the final wheels contracted more and became too small. Contraction was caused in another way; it was very essential in making any castings that the metal should not be too high in phosphorus, 0.07 per cent. being the maximum. He favoured 0.05 per cent. for both sulphur and phosphorus. Regarding pouring temperatures, it was no use attempting simply to reach a little above the melting point. The metal must be taken above the melting point by 300 deg. C., and even with that margin no time must be wasted in getting the boxes cast.

Facing Sand.

As to sand, he at one time thought he should have to send to Sheffield for special mixtures, which were, of course, fairly expensive. But he soon dropped them, because he found that within the limits of weight he had mentioned they could make perfectly good sand mixtures with ordinary red moulding sand, and mixing it up to a varying extent with ordinary floor sand and silica sand. But the basis of all sand mixtures was red sand, which he obtained from anywhere round Birmingham or Tipton. He would like to emphasise one point, that they must not try to get on facing sand the maximum refractoriness. Everybody seemed to insist in steel castings that the maximum of refractoriness was an essential condition upon being able to make a good casting surface. But his experience was that the mixture should be so regulated that it just nearly reached the point of fusion, in contact with the molten metal. If that was done, they would find the sand caked, and that the cake came off very easily and left a beautiful surface on the casting. He must state also that he did not give way to the Italians' steel castings, or those of any other Continental countries in the finish of such castings by their English converter process. He found that for every day to day work the converted process gave the most reliable results.

The Author's Reply.

MR. BRADLEY, whom the President said would deal with the questions raised in writing, briefly and hurriedly replied on account of the lateness of the hour. Certainly they required the card system as a guide and a record. Generally speaking, in the repetition shop they would expect to use green sand. They all preferred electric welding where possible; it was much quicker and cheaper than the other processes. A question was asked as to oxy-acetylene being much better because it took longer to generate the heat so as not to interfere with the yield-point. But it was not the yield-point, but the cooling process which caused the hardness. Regarding fluidity in Tropenas, he considered better fluidity was obtained from them than from electric furnaces, but they could secure good fluidity from the latter, and they could shank every ounce of metal. As to annealing, they annealed all castings unless they were in a real hurry. Generally, they annealed according to the carbon; the lower the carbon the higher the temperature required. As regards casting temperature, he did not believe there was any instrument made which would record the different proper temperatures, taken from furnace to mould; he should say somewhere between the region of 1,560 to 1,660. In reference to sand, they would find at the exhibition a green sand casting 2 to 2½ in. thick which was equal in skin to a good many cast-iron castings. He disagreed that it was cheaper to make a dry-sand than a green-sand mould. A good deal depended on the class of casting and one's experience of sands. They must get the sand to withstand the metal. He must say that he had tried all up to 4 in., but had never found anything to stand up like the Yorkshire sand. Belgian was all right, but when they got up to 1 in. and over there was nothing like Yorkshire sand, from which they obtained a much better skin. Also a good deal depended on the way a man rammed his mould; this was where the skilled moulder came in. It was much more difficult to make a good green sand mould and get a good casting than a dry sand mould on that account. Referring to Mr. Harley's comment about wheels, they had made them with green sand and dry, and also with the outside chill for the outside rim, and had found the best results from green sand.

SAFETY WORK IN FOUNDRIES.

MR. A. R. BARTLETT (London) pointed out that a man who was temporarily disabled through an accident was frequently a direct loss to his employer in regard to production, because there was not only delay, but in finding a man to take his place they might not secure one so efficient or so well acquainted with the conditions of that particular job. He favoured a machine riddle for sand, and wherever possible using mechanical means and having them properly safeguarded. He suggested that employers should try to interest the men in safety measures, and it must necessarily start with the management. At the same time it was very difficult to get the men to wear goggles. Lighting and ventilating were great points in safety, but the first essential was caution.

WILLIAMS, FOSTER & COMPANY, and Pascoe, Grenfell & Sons, Limited, manufacturers of copper, yellow metal and spelter, etc., of Leadenhall Buildings, E.C.3, have removed to 4, London Wall Buildings, London, E.C.2.

Some Influences of Low Temperature on the Strength and other Properties of Cast Iron.*

By A. Campion, F.I.C. (Falkirk) and J. W. Donaldson, B.Sc., A.I.C. (Greenock).

Introduction.

James Watt only succeeded in producing a working steam engine after obtaining the assistance of John Wilkinson to show him how to cast and bore the cylinders, and from that time to the present the engineer has always been largely indebted to the iron founder.

Modern engineering progress involving the use of high speeds, temperatures and pressures, together with the increase in the size of engines, has been facilitated in no small degree by the exertions of the ironfounder. The limits have not yet been reached, and it appears probable that in the immediate future the engineer will make still further demands upon the founder and metallurgist for castings of even greater complexity, and to meet more stringent specifications as regards strength and reliability.

Although cast iron is one of the most extensively employed, it is at the same time the most complex of the ferrous materials used in engineering construction, and the one least understood as regards its constitution and properties under varying conditions and treatment.

The engineer requires material which possesses considerable strength and reliability not only at ordinary temperature and pressure, but which also retains its strength, shape and size when submitted to the action of higher temperatures and pressures.

It must be frankly admitted that metallurgical progress in regard to cast iron has not kept pace with that of engineering design, but it is of the utmost importance that this deficiency be made good at the earliest possible opportunity, and that cast iron receive full and careful attention and investigation of its constitution and properties.

The future progress of engineering design and construction will largely depend upon the ability of the metallurgist to produce material capable of withstanding more severe conditions of service, and of the founder to cast it. During the last ten years the authors have given very serious and careful consideration to the manufacture, selection and testing of iron castings for use in internal combustion engines and other positions where the material is submitted to the action of high pressures, temperatures, superheated steam and other severe influences.

The object of the present paper is to set out some of the results of tests which have been made on irons of different qualities and compositions in the hope that they may prove of interest to the members, provoke a discussion from which some suggestions for further work may arise, and at the same time stimulate interest in this very important question.

Material.

Three irons have been selected from amongst a number which the authors have examined as representing widely different classes of material, and for which fairly complete sets of figures are available as regards :—(1) Change of volume after repeated heating and cooling to and from (a) 450 deg C., (b) 550 deg. C. (2) Tensile strength after annealing for constant time at temperatures between atmospheric and 700 deg. C. (3) Tensile strength at temperatures between atmospheric and 500 deg. C.

The chemical analyses of the materials are shown in Table 1.

TABLE I.—*Chemical Analyses of Materials Used.*

	A1.	A2.	A3.	A4.	A5.	A6.
Total C.	3.286	3.144	2.845	3.377	3.382	3.295
Gr. C. ..	2.716	2.334	1.950	2.647	2.662	2.599
C. C. ..	0.570	0.810	0.895	0.730	0.720	0.696
Si. ..	1.745	1.840	1.447	1.560	1.237	1.716
S. ..	0.110	0.110	0.155	0.073	0.061	0.072
P. ..	1.541	0.868	1.036	0.950	0.751	0.766
Mn. ..	0.155	0.510	0.460	0.540	1.080	1.660

A1 is an iron used for stove plate and other light castings.

A2 is a strong iron used for steam turbines and other marine work.

A3 is a semi-steel used with marked success for dies for tube drawing.

The first two are somewhat similar in composition so far as total carbon, silicon and sulphur are concerned, but have very different percentages of manganese and phosphorus. Although the quantity of total carbon is nearly the same in both irons there is an appreciable variation in the manner in which it exists.

In addition to the three irons referred to above there are given changes in volume, weight and tensile strength after repeated heating from 1 to 20 times, at (a) 450 deg. C. (b) 550 deg. C. and cooling of other three irons whose compositions are shown also in Table 1.

Experimental Methods.

The necessary number of bars 12 in. long and 1½in. dia. were cast from the same ladle, all at one time and under identical conditions of irons A1, A2, and A3. The bars were then rough-machined before treatment. Bars 1 in. dia. by 9 in. long were cast for irons A4, A5, A6, and machined to size before treatment.

Change of volume.—Cylindrical test pieces exactly 1 in. dia. and 6 in. long were prepared from A1, A2 and A3, and approximately 0.625 in. dia. and 5.25 in. long from A4, A5 and A6.

The specimens of the first three were placed in an electrically-heated furnace with closed ends and through which a current of coal-gas passed. The test pieces were gradually raised to the desired temperature, maintained at it for 7 hours and then allowed to cool in the furnace. The dimensions of the bars were measured after each five heatings by means of a vernier reading to a ten-thousandth of an inch.

The A4, A5 and A6 bars were heated for 6 hr. periods without the coal-gas passing through the furnace, being simply bedded in asbestos wool. The dimensions in these experiments were taken by means of micrometer calipers reading to ten-thousandths of an inch.

The temperatures of heating (450 deg. C. and 550 deg. C.) were chosen because the experiments were originally made to determine the most suitable material to use in the liner and piston of a type of internal combustion engine in which the average temperature of the metal had been found to be between 400 deg. C. and 500 deg. C. All further experiments have been made at the same temperatures for comparison purposes. The fact that the results of the tests were found to agree very closely with those obtained in actual practice indicates that the temperatures were well chosen.

Some results are also given for irons A4, A5 and A6 heated to 550 deg. C. after having been previously submitted to 21 treatments at 450 deg. C. and cooled in air. These results are of interest inasmuch as they give an indication of the possible effect of occasional overheating, such as might occur in the event of the cooling medium running short or circulation interrupted.

Annealing.—The test bars, 6 in. long, rough-turned and screwed, 1¼ in. Whitworth thread at the ends, were placed in an electric muffle-furnace, maintained at the desired temperature for 4 hrs. and then allowed to cool in the furnace, precautions being taken to reduce oxidation to a minimum in all experiments. The bars were then machined to exactly ½ sq. in. area in the parallel portion.

Strength at High Temperatures.—The test pieces were of the same dimensions as those employed in the annealing experiments. They were screwed into the sockets of long holders, and surrounded by an electrically heated furnace which was attached to the machine. The holders themselves were surrounded for a considerable distance by the furnace in order to ensure thorough and uniform heating of the test pieces. Thermo-couples were clamped to the test pieces, so that the actual temperature of the metal and not of the furnace was determined. The bars were

* A Paper read before the Birmingham Conference of The Institute of British Foundrymen.

slowly heated to the desired temperature and when it had become constant, was maintained for half an hour and then tested. Special precautions were taken to ensure that the rate of loading of the specimens was the same in all cases, and as a further check an autographic record was taken of every test.

Each of the materials was tested in the condition as cast and also after having been annealed, by heating to 400 deg. C. for 4 hrs. and allowed to cool in the furnace, in order to remove strains due to casting or machining.

Strength after Repeated Heating and Cooling.

The growth test bars of irons A1, A2 and A3 after treatment were prepared and tested for tensile strength. Materials A4, A5 and A6 were tested more fully as the necessary number of previously machined test pieces were treated and tested after each treatment. 10 sets of bars were placed in the furnace, and one set taken out after each of the first 6 heatings and one each after the 9th, 15th, and 20th heating and then tested. The test pieces were 8 in. long by ½ sq. in. area in the parallel portion and screwed ⅝th. Whitworth thread at the ends.

Consideration of Experimental Results.

The average results of all the experiments are given in Tables 2 to 12 and graphically in Figs. 1 to 6.

Changes in Volume Consequent upon Repeated Heating and Cooling.—A1 shows by far the largest variations when heated in a non-oxidising atmosphere of any of the materials considered in the present paper. The results of the 450 deg. C. heatings are erratic and exhibit no tendency to change in any particular direction. The maximum growth is found after 10 heatings, when the volume decreases until after 20 heatings where a slight increase is again registered, but it appears that this material never attains a constant volume. Heating to 550 deg. C. causes a continued growth and even after 55 treatments there is no indication that constancy will obtain. It is evident that this material is most unsuitable for use in positions where permanency of size or shape is required, especially if, as is so often the case, the material is subject to oxidising influences. The effect of the treatment is to reduce seriously the strength of the iron.

TABLE II.—*Change of Volume After Repeated Heating to 450 deg. C. and Cooling.*

Condition.	A1. Volume cub. in.	A1. Change %	A2. Volume cub. in.	A2. Change %	A3. Volume cub. in.	A3. Change %
Original	4.7124		4.7124		4.7124	
After 5 heatings	4.7162	+0.0806	4.7156	+0.0679	4.7147	+0.0488
,, 10 ,,	4.7184	+0.1274	4.7178	+0.1145	4.7167	+0.0912
,, 15 ,,	4.7176	+0.1103	4.7261	+0.2907	4.7197	+0.1549
,, 20 ,,	4.7170	+0.0976	4.7263	+0.2949	4.7187	+0.1359
,, 25 ,,	4.7171	+0.0995	4.7263	+0.2949	4.7187	+0.1359

TABLE III.—*Change of Volume after Repeated Heating to 550 deg. C. and Cooling.*

Condition.	A1. Volume cub. in.	A1. Change %	A2. Volume cub. in.	A2. Change %	A3. Volume cub. in.	A3. Change %
Original ..	4.7124		4.7124		4.7124	
After 5 heatings	4.7273	+0.3160	4.7193	+0.1460	4.7176	+0.1103
,, 10 ,,	4.7396	+0.5770	4.7196	+0.1530	4.7227	+0.2185
,, 15 ,,	4.7556	+0.9170	4.7202	+0.1660	4.7227	+0.2185
,, 20 ,,	4.7692	+1.2050	4.7205	+0.1740	4.7227	+0.2185
,, 25 ,,	4.7892	+1.6290	4.7205	+0.1720	4.7227	+0.2185
,, 30 ,,	4.8006	+1.8720	4.7205	+0.1720	4.7227	+0.2185
,, 35 ,,	4.8183	+2.2480	—		—	
,, 40 ,,	4.8309	+2.5140	—		—	
,, 45 ,,	4.8437	+2.7860	—		—	
,, 50 ,,	4.8479	+2.8750	—		—	
,, 55 ,,	4.8531	+2.9860	—		—	

TABLE IV.—*Change of Volume After Repeated Heating to 450 deg. C. and Cooling.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
Original ..	1.6118		1.6900		1.6972	
After 1 heating	1.6146	+0.170	1.6921	+0.006	1.6995	+0.130
,, 2 heatings	1.6193	+0.460	1.6944	+0.260	1.7017	+0.260
,, 3 ,,	1.6195	+0.480	1.6919	+0.112	1.7012	+0.230
,, 4 ,,	1.6130	+0.070	1.6890	−0.059	1.6983	+0.060
,, 5 ,,	1.6124	+0.040	1.6890	−0.059	1.6978	+0.090
,, 6 ,,	1.6119	+0.010	1.6878	−0.030	1.6967	−0.030
,, 9 ,,	1.6149	+0.190	1.6897	−0.017	1.6967	−0.030
,, 12 ,,	1.6164	+0.280	1.6897	−0.017	1.6961	−0.060
,, 15 ,,	1.6137	+0.120	1.6864	−0.213	1.6931	−0.240
,, 18 ,,	1.6134	+0.100	1.6864	−0.213	1.6928	−0.260
,, 20 ,,	1.6134	+0.100	1.6864	−0.213	1.6928	−0.260

TABLE V.—*Change of Volume After Repeated Heating to 550 deg. C. and Cooling.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
Original ..	1.7642		1.6967		1.7754	
After 1 heating	1.7577	−0.362	1.6834	−0.783	1.7681	−0.411
,, 2 heatings	1.7568	−0.413	1.6844	−0.724	1.7666	−0.495
,, 3 ,,	1.7637	−0.002	1.6887	−0.471	1.7672	−0.461
,, 4 ,,	1.7653	+0.068	1.6892	−0.442	1.7675	−0.444
,, 5 ,,	1.7662	+0.119	1.6925	−0.247	1.7693	−0.343
,, 6 ,,	1.7667	+0.147	1.6928	−0.229	1.7686	−0.383
,, 9 ,,	1.7670	+0.164	1.6931	−0.212	1.7681	−0.383
,, 12 ,,	1.7679	+0.215	1.6920	−0.277	1.7681	−0.383
,, 15 ,,	1.7682	+0.232	1.6914	−0.312	1.7681	−0.383
,, 18 ,,	1.7679	+0.215	1.6914	−0.312	1.7681	−0.383
,, 20 ,,	1.7679	+0.215	1.6914	−0.312	1.7681	−0.383

TABLE VI.—*Change of Volume After Repeated Heating to 550 deg. C. and Cooling After Previous Treatment at 450 deg. C.*

Condition.	A4. Volume cub. in.	A4. Change %	A5. Volume cub. in.	A5. Change %	A6. Volume cub. in.	A6. Change %
After 20 heatings at 450 deg. C.	1.5430	—	1.6864	—	1.6927	—
After 1 heating	1.5430	—	1.6836	−0.166	1.6930	+0.018
,, 2 heatings	1.5450	+0.129	1.6866	+0.012	1.6944	+0.100
,, 3 ,,	1.5460	+0.194	1.6905	+0.243	1.6956	+0.171
,, 4 ,,	1.5470	+0.259	1.6916	+0.308	1.6970	+0.254
,, 5 ,,	1.5460	+0.194	1.6930	+0.391	1.6959	+0.248
,, 6 ,,	1.5470	+0.259	1.689	+0.195	1.6944	+0.100
,, 9 ,,	1.5480	+0.324	1.6897	+0.195	1.6944	+0.100
,, 12 ,,	1.5480	+0.324	1.6908	+0.261	1.6944	+0.100
,, 15 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100
,, 18 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100
,, 20 ,,	1.5480	+0.324	1.6903	+0.231	1.6944	+0.100

TABLE VII.—*Changes of Weight After Repeated Heating at 450 deg C. and Cooling.*

Condition.	A4. Weight Grams	A4. Change %	A5. Weight Grams	A5. Change %	A6. Weight Grams	A6. Change %
Original ..	189.220	—	198.690	—	199.320	—
After 1 heating	189.220	—	198.690	—	199.320	—
,, 2 heatings	189.225	+0.022	198.695	+0.002	199.320	—
,, 3 ,,	189.242	+0.011	198.705	+0.007	199.340	+0.010
,, 4 ,,	189.240	+0.011	198.715	+0.012	199.340	+0.010
,, 5 ,,	189.240	+0.011	198.715	+0.012	199.340	+0.010
,, 6 ,,	189.245	+0.013	198.715	+0.012	199.345	+0.012
,, 9 ,,	189.295	+0.039	198.790	+0.050	199.390	+0.035
,, 12 ,,	189.310	+0.047	198.812	+0.061	199.410	+0.045
,, 15 ,,	189.320	+0.053	198.815	+0.063	199.420	+0.050
,, 18 ,,	189.340	+0.063	198.820	+0.066	199.435	+0.057
,, 20 ,,	189.355	+0.071	198.835	+0.073	199.450	+0.065

TABLE VIII.—*Changes of Weight After Repeated Heating to 550 deg C. and Cooling.*

Condition.	A4. Weight Grams	A4. Change %	A5. Weight Grams	A5. Change %	A6. Weight Grams	A6. Change %
Original ..	207.130	—	199.490	—	208.390	—
After 1 heating	207.160	+0.014	199.510	+0.010	208.400	+0.004
,, 2 heatings	207.180	+0.028	199.530	+0.020	208.420	+0.014
,, 3 ,,	207.230	+0.048	199.590	+0.050	208.470	+0.038
,, 4 ,,	207.250	+0.057	199.600	+0.055	208.490	+0.047
,, 5 ,,	207.260	+0.062	199.605	+0.057	208.500	+0.052
,, 6 ,,	207.260	+0.062	199.610	+0.060	208.500	+0.052
,, 9 ,,	207.290	+0.077	199.635	+0.072	208.520	+0.062
,, 12 ,,	207.310	+0.086	199.650	+0.080	208.550	+0.076
,, 15 ,,	207.210	+0.086	199.655	+0.082	208.550	+0.076
,, 18 ,,	207.330	+0.096	199.665	+0.087	208.570	+0.086
,, 20 ,,	207.350	+0.106	199.680	+0.095	208.590	+0.096

TABLE IX.—*Showing the Effect of Annealing at Various Temperatures.*

Temperature, deg. C.	A1. Tons per sq. in.	A1. Change %	A2. Tons per sq. in.	A2. Change %	A3. Tons per sq. in.	A3. Change %
15	10.20	—	15.00	—	16.60	—
100 ..	10.50	+ 2.94	15.05	+ 0.33	16.45	− 0.903
200 ..	10.45	+ 2.45	15.10	+ 0.66	16.50	− 0.603
300 ..	10.85	+ 6.37	14.84	− 1.06	16.20	− 2.400
400 ..	11.00	+ 7.84	14.40	− 4.00	16.80	+ 1.204
500 ..	10.70	+ 4.90	14.10	− 6.00	15.90	− 4.216
600 ..	9.55	− 6.37	13.20	− 12.60	14.90	− 10.240
700 ..	8.20	− 19.61	11.84	− 21.06	13.40	− 19.270

TABLE X.—*Strength at Elevated Temperatures in Cast and Annealed Condition.*

Temperature	A1. Tons per sq. in. As cast.	A1. Annealed.	A2. Tons per sq. in. As cast.	A2. Annealed.	A3. Tons per sq. in. As cast.	A3. Annealed.
15	10.15	11.00	15.00	15.00	16.60	16.80
100	9.90	11.00	14.92	15.17	16.40	16.80
200	9.70	11.50	14.40	14.80	16.05	16.90
250	—	—	13.90	—	15.65	—
300	10.15	11.25	13.30	14.90	15.90	16.90
350	—	—	14.00	—	—	—
400	10.20	11.30	14.80	15.08	16.95	16.90
500	10.05	11.00	13.95	14.40	15.90	15.84
600	7.30	8.10	12.80	—	—	—
700	3.35	4.00	6.40	—	—	—
800	—	—	2.70	—	—	—

A2 shows a maximum percentage of growth at 450 deg. C. which is in excess of that of A1 after 20 heatings, but the volume has then become permanent. The maximum growth of this sample at 550 deg. C. is also attained after 20 heatings, but is less in amount than shown by the same material at the lower temperature, and in this respect it differs from the other irons with which the authors have so far experimented, for they have all shown a greater increase at 550 deg. C. than at 450 deg. C. This iron shrinks a little between 20 and 25 heatings, but then remains constant. The effect of the repeated heating is to reduce very considerably the strength, although in a less degree than A1.

A3 shows a much smaller percentage of change than either A1 or A2 at 450 deg. C. The maximum increase is reached after 15 heatings, which is followed by a reduction until 20 heatings when permanency of size is attained. Heating this material 10 times at 550 deg. C. produces an increase of volume greater than the maximum obtained under 450 deg. C. treatment, but it shows no further change even after 30 heatings. It would appear from these results that semi-steel is a more suitable material to employ when alteration of size or shape is to be avoided than ordinary cast iron, as the casting could be heated and cooled a few times before being put into service and, further, the strength is comparatively little affected by the treatment.

A4 reaches its maximum size at the third heating, then steadily contracts until the sixth, increasing again to the 12th, and then shows no further change. The total amount of growth is greater than that of either of the first three irons with the exception of A1 at 550 deg. C. Although the effect of treatment at 550 deg. C. is to cause a quicker attainment of constant size the amount of the increase is greater than that at the lower temperature, and curiously enough the first three heatings produce a diminution instead of an increase of volume. The effect of treatment at 550 deg. C. on the material after it has been heated 20 times at 450 deg. C. is a steady increase of size for nine heatings, when no further change takes place.

Heating A5 at 450 deg. C. at first causes an increase of volume reaching its maximum at the 2nd treatment, but between 3rd and 15th a steady diminution of volume results, when at the latter constancy is obtained. Heating this material at 550 deg. C. causes a contraction to take place, which diminishes to the 9th, then increases slightly to 15th, after which no further change takes place. Heating this material to 550 deg. C., after previously being submitted to 20 treatments at 450 deg. C., causes a steady increase in volume for the first 12 heatings and shows no further change after a slight decrease at 15th.

Heating A6 at 450 deg. C. causes it to behave in a very similar manner to A5, although contraction of volume begins a little later, and the ultimate reduction of size is slightly greater than that of either A4 or A5. Heating to 550 deg. C. causes a contraction in volume after the first four heatings, but no further change occurs as a result of subsequent treatment. Heating to 550 deg. C. after previous treatment at 450 deg. C. produces a growth which reaches its maximum at the 4th; between the 5th and 6th heatings there occurs a considerable reduction in volume, but further heatings produce no change. It is to be noted that this iron retains its strength after repeated heating and cooling better than any other which the authors have mentioned in this Paper; in fact, the strength is actually greater to the extent of 3.21 per cent. after the 450 deg. C. treatment than the original, while the 550 deg. treatment has resulted in an increase of 3.44 per cent. on the strength of the original iron.

The satisfactory behaviour of this iron the authors consider to be mainly due to the high manganese and moderate phosphorus content. It is of interest to note that irons A4, A5, A6 are very much alike in composition except for the manganese, and that the loss of strength is less as the manganese increases.

TABLE XI.—*Change of Strength After Repeated Heating and Cooling.*

Condition.	450°C.						550°C.					
	A4.		A5.		A6.		A4.		A5.		A6.	
	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.	Tons per sq. in.	Change per cent.
Original	12.96	—	13.36	—	14.73	—	12.96	—	13.36	—	14.73	—
After 1 heatings ..	12.96	—	13.87	+ 3.817	14.31	— 2.851	12.49	— 3.626	13.33	— 0.224	14.09	— 4.344
,, 2 ,, ..	12.34	— 4.780	13.58	+ 1.646	14.72	— 0.067	12.74	— 1.690	13.38	— 0.149	14.11	— 4.209
,, 3 ,, ..	12.83	— 1.003	13.51	+ 1.122	14.46	— 1.833	12.59	— 2.855	13.41	+ 0.374	14.49	— 1.629
,, 4 ,, ..	12.82	— 1.080	13.52	+ 1.197	14.32	— 2.873	12.45	— 3.935	13.65	+ 2.170	14.48	— 1.697
,, 5 ,, ..	12.25	— 5.470	13.55	+ 1.422	14.84	+ 0.746	12.65	— 2.392	13.67	+ 2.320	14.64	— 0.611
,, 6 ,, ..	12.69	— 2.083	13.31	— 0.374	14.91	+ 1.222	12.04	— 7.098	13.48	+ 0.898	14.63	— 0.678
,, 9 ,, ..	11.90	— 8.178	13.15	— 1.571	14.98	+ 1.697	10.83	—16.430	13.41	+ 0.374	14.80	+ 0.475
,, 15 ,, ..	10.72	—17.280	13.12	— 1.795	15.03	+ 2.036	9.32	—28.081	13.36	—	14.93	+ 1.357
,, 20 ,, ..	10.52	—18.820	13.22	— 1.020	15.20	+ 3.210	7.25	—44.060	13.41	— 1.690	15.24	+ 3.440

TABLE XII.—*Change of Strength After Repeated Heating and Cooling*

Condition	A1.		A2.		A3.	
	Tons per sq. in.	Change %	Tons per sq. in.	Change %	Tons per sq. in.	Change %
Original ..	10.20	—	15.00	—	16.60	—
After 25 heatings at 450 deg. C.	9.72	— 4.70	13.50	—10.00	14.85	10.51
After 25 heatings at 550 deg. C.	—	—	13.00	—13.30	13.99	15.70
After 55 heatings at 550 deg. C.	7.50	—26.47	—	—	—	—

Changes of Weight Consequent upon Repeated Heating and Cooling.

The determinations were made only on the last three irons whose analyses are given in Table I., and the results, which call for little comment, are given in Tables VII. and VIII. It will be observed that in all cases there is a steady and fairly regular increase after each heating. At 450 deg. C. A6 shows a rather smaller total increase than A4 or A5, whilst at 550 deg. C. A4 gains rather more than A5 and A6.

Annealing.—The results of these experiments are shown in Table IX. The principal features are the very pronounced weakening which results from annealing at temperatures above 400 deg. C. It has previously been shown by Longmuir and Hatfield that annealing grey cast irons at high temperature destroys the strength. The other feature is the maximum strength which the materials attain at a temperature between 200 deg. C. and 400 deg. C., and which varies with different irons. The loss of strength at 700 deg. C., the highest temperature employed in these experiments, is practically of the same order for all materials.

A1 increases up to 400 deg. C., when it is 7.84 per cent. stronger than the untreated material, at 500 deg. C. a reduction occurs and continues to 700 deg. C., when the strength is reduced by 19.6 per cent.

A2 increases slightly when treated at temperatures up to 200 to 250 deg. C., after which there is a steady fall to 21.06 per cent. below the original at 700 deg. C.

A3 shows a loss of strength at all temperatures up to 300 deg. C., then it increases to 1.204 per cent. above the untreated at 400 deg. C., afterwards decreasing until at 700 deg. C. the strength is 19.27 per cent. less than the orginal material.

These results are somewhat difficult to explain at present. It is conceivable that the release of internal stress might cause a certain amount of increase in the strength, but the fluctuation between minima and maxima points seems to require some further explanation. The authors have examined a number of annealed irons microscopically, but it would make the paper too long to include the results of their work in this direction, so that they prefer to reserve that part of the investigation for another occasion and after they have more fully studied the subject. It appears, however, that the arrangement and dis-

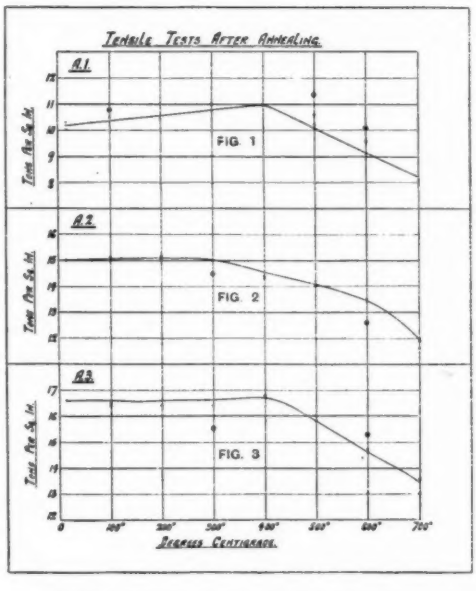
tribution of the graphite, carbides and phosphides plays a very prominent part, as does also the contiguity of these constituents.

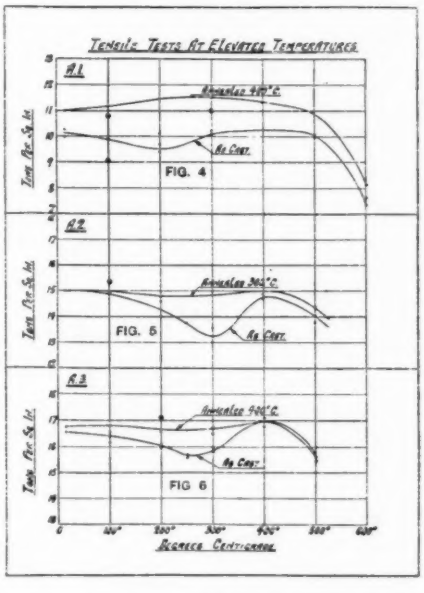
Strength at Elevated Temperatures.

The means of the results on the material "As cast," and also after annealing, are shown in Table X. and graphically in Figs. 4, 5 and 6.

Very few results of high temperature tests of cast iron have so far been published, and the majority of these are not in agreement with those obtained by the present authors, or with some unpublished results of other investigators of which they have knowledge.

Tests on Material in Natural Condition.—The most striking feature about these results is the well-defined maxima and minima points exhibited by all materials, and which occur at nearly the same temperature for each of the materials. A1 exhibits a minimum at 200 deg. C. which is, although well marked, less pronounced than in the case of A2 and A3. The maximum at 400 deg. C. is not well marked although distinct, and the strength at this point is approximately ½ per cent. greater than that of the original material tested at 15 deg. C. At temperatures above 500 deg. C. A1, A2 and A3 all lose strength somewhat rapidly, A1 has a strength of only 3.35 tons per sq. in. at 700 deg. C. or 67 per cent. reduction.





A2 is at minimum strength at 300 deg. C. and maximum at 400 deg. C., both points being much more pronounced than in the case of A1. The strength falls away continuously from 15 to 300 deg. C. where the reduction amounts to 11.3 per cent., rises to 400 deg., where the strength is about the same as at 15 deg., and falls away again to 500 deg. to 7.0 per cent. below the original.

A3 behaves similarly to A2, giving its highest strength at 400 deg. with an increase of 2.1 per cent. The minimum, which is 5.95 per cent. below the 15 deg. result, occurs at 250 deg. C., after which it increases to 400 deg. C. and then quickly falls away to 15.9 tons per sq. in., representing a reduction of 4.22 per cent. at 500 deg. C.

Tests of Material Previously Annealed.—The results generally are of the same type as obtained with the material in the untreated condition, but the variations of strength are smaller. The effect of the annealing has been to give greater regularity, and it will be noticed that the curves in Figs. 4, 5 and 6 are smoother, but the dip between 250 and 300 deg. C. is still evident in A2 and A3.

A1 gives a totally different result after annealing than the "as cast" material; the maximum strength is obtained at 200 deg. C., the point at which the minimum is given by the untreated iron, and further there appears no marked rise or fall below 500 deg. C.

The Authors are at present unable to offer an adequate explanation of these phenomena but are carrying out at present some investigations, the results of which they hope may shed some light on this intricate but exceedingly interesting and important problem. They have reason to think that the distribution of the graphite and phosphide eutectic is largely responsible, as well as the nature and amount of the gases occluded and dissolved in the iron.

Strength after Repeated Heating and Cooling.

The details of the tests of the six materials after repeated heating at 450 deg. and 550 deg. C. are shown in Tables XI. and XII. A1 and A2 both suffer a considerable reduction of strength as a result of the treatment as also does A4. It is somewhat curious that after 25 heatings at 450 deg. C., A2 shows a percentage loss of strength of about double that lost by A1 under similar treatment, but when the temperature of heating is 550 deg. C. the position is reversed.

A4 shows a very great loss of strength at both temperatures, especially after the sixth heating.

A5 retains its strength to a very large degree at both temperatures, the percentage reduction being only 1.02 and 1.69 after 20 heatings at 450 deg. and 550 deg. respectively.

A6 behaves differently from any of the others, inasmuch as it actually appreciates in strength at both temperatures, a fact that has already been noted in an earlier section of this Paper.

The irons dealt with in this Paper all contain the normal proportion of total carbon as they were not made from any specially selected brand of iron, the object being to obtain information as to the behaviour of castings made from ordinary everyday material, with or without special additions or treatment. Total carbon is a most important factor in determining the behaviour of iron under repeated heating and cooling however the heating may be applied, and from information in their possession the Authors are confident that had the total carbon in A6 been under 3.00 per cent. it would have given still better results as regards growth and strength after repeated heating and at elevated temperatures. They are aware that in some quarters the use of manganiferous cast iron is objected to for reasons which it is difficult to understand, but it is their experience that such material gives results, in practice, much superior to that which contains low manganese. A6 is an iron which can be quite easily machined at a good speed and gives good surfaces both as regards appearance and wearing properties.

The investigations are being continued, and it is hoped to publish very shortly further results upon other materials of the cast-iron type. Semi-steel appears to offer at least a partial solution to the problem of providing a material capable of being easily cast, which will retain a greater proportion of its strength at atmospheric temperature when submitted to the action of more elevated temperatures. The authors are experimenting

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with such material not only in its ordinary form, but also containing certain proportions of special constituents, and prepared under different conditions. The question of heat treatment of cast iron and semi-steel is also receiving their attention.

In the present Paper the authors have purposely given only the results of tests as they have been obtained and refrained from propounding any theory to explain the various phenomena, firstly because their main object was to show how irons of widely different qualities were affected by various heat influences and secondly because the theoretical aspect of the question is of so much importance that they deemed it better to reserve it for another occasion when it could receive more detailed attention.

The authors desire to acknowledge their indebtedness to all those who have assisted them by providing material and in other ways. To Mr. J. Cameron, of Kirkintilloch, for providing the semi-steel and for the great interest he has shown in the experiments.

They also desire to thank the directors of Messrs. Scotts' Shipbuilding & Engineering Company, Limited, Greenock, in whose works and laboratories a considerable part of the experimental work was carried out, for permission to make use of the data so obtained.

Systematic Gating.

By W. Pyatt.

All foundries have scrap castings, but whatever the percentage may be, it is generally attributed to various causes which in many cases are wrong ones. In many foundries there is a much larger percentage of scrap castings through faulty gating than most foundrymen realise, owing chiefly to the fact that the action of the inflow of molten metal cannot be seen. The defects caused through incorrect gating are so varied that they are consequently classified incorrectly. In many cases these are attributed to sulphur, phosphorus, damp moulds, etc. Such defects can be eliminated by a system of gating instead of allowing the moulder to search the foundry for gates which he thinks will answer, and which very often are unsuitable, but it escapes the foreman's notice until casting time. Additionally they may be in the wrong position, with scabs, blow holes, etc., as a result. A system can be adopted in any foundry where repeat orders from same pattern are expected, even with small alterations. A partitioned rack should be provided in foundry pattern stores, and the pattern number plainly marked on each box. Having carefully determined the required area of gate according to size and design of casting, these gates should then be made of good hard wood and plainly marked with pattern number to correspond with racks. Additionally, the position of the gate or gates should be marked on the pattern with a distinctive colour. Having adopted a system it is imperative that gates are replaced in their respective racks when not in use.

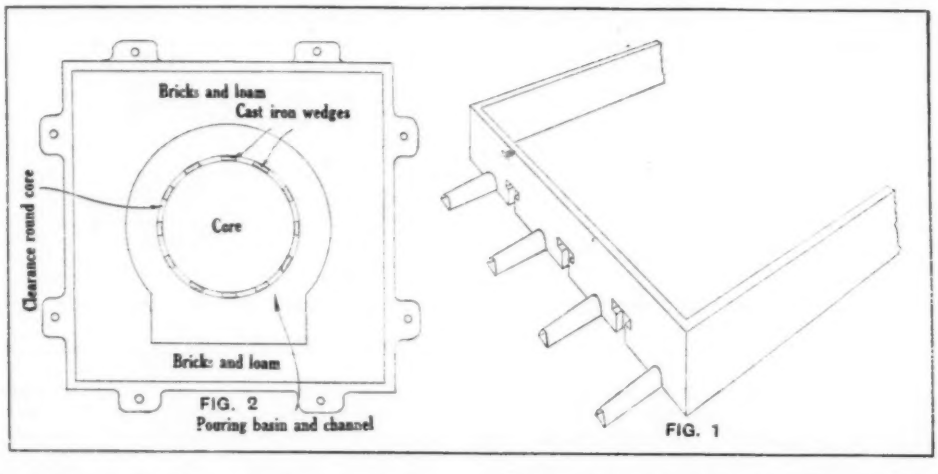
The advantages of systematic gating may be exemplified by a planing machine table of any dimension. The usual practice is to cast face-down on a levelled bed.

Instead of being level it is preferable to incline the surface 1 in. in 5 ft., and to fix gates to enter in volume at the bottom, as shown in Fig. 1. The metal will then roll quietly up hill. No venting is required, for the pressure of metal will force down the gases, providing a good open sand is used, especially if skin dried. A similar system can be applied to such castings as lathe beds.

On account of the accumulation of dirt on flowing metal, it is sometimes policy, where parts have to be machined, to gate on the top of the mould in order to ensure a clean casting below the head, as in such castings as marine cylinders and rams. The author's system of gating marine cylinders weighing up to 10 tons each, was to cast the bore vertically, the mould being made by striking in loam, and built up with plates and cinders. The back of the top plate was constructed so as to form a pouring basin. The circular hole in top plate is to allow centre core to pass through. This was made ½ in. larger in dia. than the main core. After striking a flat surface, it is dried and turned over, the pouring basin is bricked up and loamed, the whole being thoroughly dried. The main core is made 18 in. longer than casting, and when in position and top plate lowered over the projecting main core, there remains ¼ in. clearance between the centre hole in the plate and the main core. This is shown in Fig. 2. This ¼ in. clearance is used as the gate, and in a 10-ton casting it is necessary to check the flow by fixing cast-iron wedges in the clearance every 6 in. By this method of gating a continuous stream of metal is obtained all round the core which ensures a clean bore.

The system applies to-day in one foundry for all cylindrical castings with good results.

Where a system applies to one class of casting it is worth while trying for others, but it must be strictly enforced once started. The result will be saving in moulders' and pattern-makers' time and material and the reduction of a large percentage of scrap castings.



THE LOFTHOUSE ENGINEERING COMPANY, LIMITED, is being wound up voluntarily, with Mr. H. F. Wareham, the chairman, as liquidator.

MR. W. H. BRITTAIN, of Storth Oaks, Ranmoor, died on June 29 at the age of 87 years. The deceased gentleman, on leaving school, was apprenticed to Messrs. Standfield, Newbould & Baildon, merchants and cutlery manufacturers, Sussex Works, Sheffield. Mr. Charles Hall carried on business at the Alma Works as file, steel, and edge tool manufacturer, under the style of "William Hall," a firm which was established in the previous century. Mr. W. H. Brittain joined Mr. Hall in partnership, and from 1860 to 1866 travelled over the Continent in the interests of the house with which he was associated. Later the business was amalgamated with Messrs. Sanderson Bros. and Newbould. At the end of 1866 Mr. Hall retired from the firm, and Mr. W. H. Brittain took charge of the works of which he was principal up to the time of his death.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

General Meeting.

A meeting of the Lancashire Branch was held on Saturday, May 6, at the Manchester College of Technology. At the opening of the proceedings Mr. W. H. Meadowcroft, the retiring branch president, occupied the chair.

Secretary's Report.

The report of the hon. secretary, Mr. J. Hogg, congratulated the members on the present state of the branch and the excellent work which had been done during the year. A varied list of lectures was prepared by the council, and all the engagements were fulfilled. The annual dinner, held on January 14, was a very enjoyable and successful event. The membership now comprised 90 members, 149 associate members, 5 associates, and 5 subscribing firms, a total of 249. These figures included the Burnley section, with 21 members and 24 associate members. Ten council meetings had been held, and were very well attended. Owing to the unfortunate dispute in the coal industry no visits to works were arranged during last summer, but it was intended to resume them, and arrangements would be made for visits to the blast furnaces at Staveley and the Keighley laboratories. Expenditure has been rather more than usual. Postage of circulars now costs 21s. monthly, as compared with 10s. 6d. before, and there had been expenses connected with the opening of the Burnley section. The balance in hand from December, 1920, was £8 11s. 4d.; on December 31, 1921, it was £6 8s. 2d. During the year one of the members of the Lancashire branch, Mr. Oliver Stubbs, had been the president of the institution. Other interesting features of the year were the annual conference of the institution at Blackpool and the fact that the Royal Charter had now been granted fully.

The report and balance-sheet were adopted and a vote of thanks to the retiring officers was passed unanimously. In replying, Mr. Meadowcroft said he was glad to have had the opportunity of assisting with the work of the institution as a branch president, and he would continue to do so in another capacity. All who were concerned with foundries knew that there was much to be done, and the institution was laying the foundation for a great and permanent improvement.

Mr. Hogg observed that one reason for his resignation was that he was convinced they had a reserve of members who, given the opportunity, would show that they were quite competent to carry the branch on successfully. The post of secretary was a very honourable one, and he desired to thank the members for having made it an exceedingly pleasant one for him.

Election of Officers.

The election of officers resulted as follows:—Branch president, Mr. J. Haigh; senior vice-president, Mr. R. A. Miles. These were unopposed. For the office of junior vice-president two names were submitted, and Mr. J. Masters was elected. There were three candidates for the post of secretary, vacated by Mr. Hogg, and Mr. T. Makemson was elected by a large majority of the total votes. Seven nominations were made for representatives to the General Council, and the ballot decided in favour of Messrs. Hogg, Meadowcroft, and Miles, with Mr. Jolley and Mr. H. Sherburn for the fourth place. Both gentlemen expressed a desire to retire in favour of the other, and eventually Mr. Jolley was selected. Nine members of the branch council were required and twelve names were submittd to the ballot, the three who received the most votes to serve for three years, the next three for two years, and the remaining three for one year. The result of the ballot was that Messrs. Jolley, Baron, and Hill were elected for three years, Messrs. Cook, Pell, and Sutcliffe for two years, Messrs. Swift, Greenwood, and Baron for one year. Messrs. R. P. Layfield and J. Nicholls were appointed auditors unopposed.

Manganese Ore in Hungary.—Some deposits of manganese ore are being opened up in the County of Veszprém, in Hungary, and a company has been formed under the auspices of the Deutsche Bank to exploit the orefield.

Three Months' Variations in Prices

The accompanying curves show the price variations during the three months ended June 30 in pig-iron, semi-finished and finished iron and steel, coke, and rubio ore delivered Middlesbrough, together with variations in tin, copper, lead and spelter. Prices of pig-iron have remained practically unchanged, with the exception of No. 3 Scotch, which has shown a

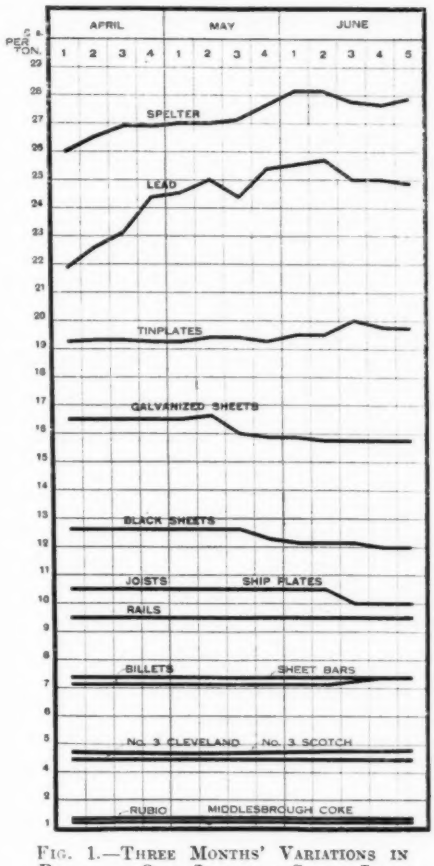


FIG. 1.—THREE MONTHS' VARIATIONS IN PRICES OF ORE, IRON AND STEEL, LEAD AND SPELTER.

slight upward tendency. Billets and sheet bars, which at the end of last quarter, on the Association price basis, differed by about 12s. 6d. per ton, are now the same price at about £7 7s. 6d. per ton. In the first quarter, the Association price was being undersold outside the area by about 15s. per ton,

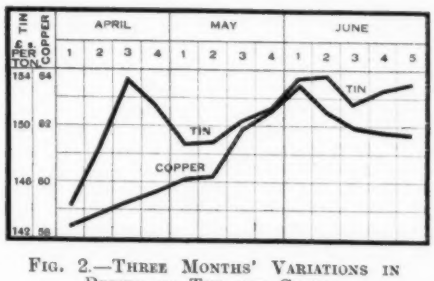


FIG. 2.—THREE MONTHS' VARIATIONS IN PRICES OF TIN AND COPPER.

whilst at the present time the Association price is several shillings higher than outside quotations.

The prices of tin, spelter and lead have shown an upward tendency during the past quarter, whilst the price of copper, after a rise from about £59 to about £62 at the beginning of June, showed a progressive decline up to the end of the month.

THE partnership heretofore subsisting between Messrs. F. J. Owen, A. G. Owen, T. H. Owen and W. P. Owen, iron, steel and general merchants, 3 and 4, Chapel Chambers, Castle Street, Swansea, under the style of Owen Brothers, has been dissolved.

Moulding Barrel Castings.

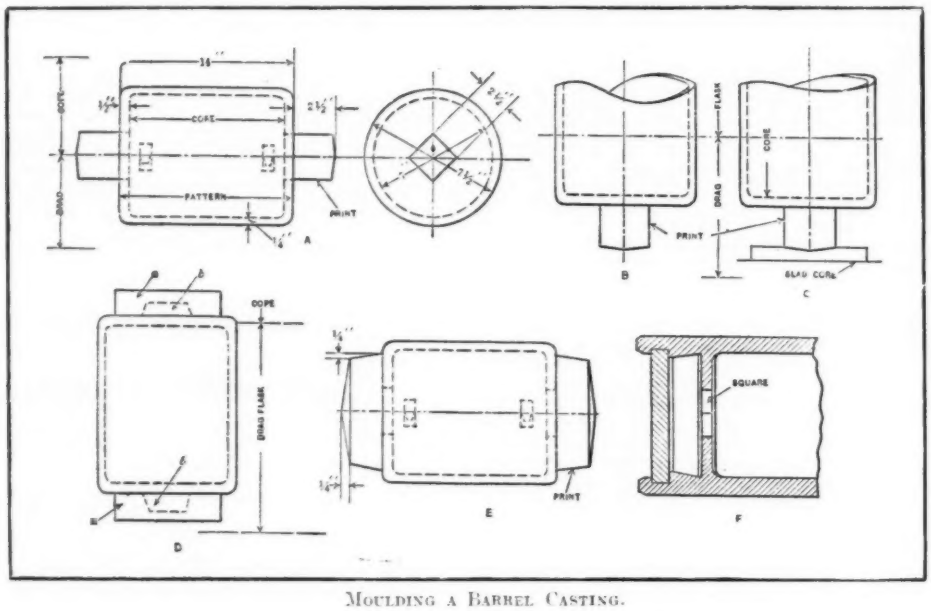
Writing in a recent issue of "Machinery," M. E. D. deals with the evolution of a pattern and core box for use in the production of large quantities of accurate cylinder or barrel castings. He states that the principal dimensions of the casting are shown at *A* in the accompanying illustration. The casting was to have core holes at each end 2½ in. square. It was desired to eliminate all machine work, and it therefore became necessary to hold the castings as close as possible to the specified dimensions.

Probably nine out of ten patternmakers would make the pattern with the parting line through the centre, and the 2½-in. core prints attached to the ends of the pattern, as shown at *A*, the core box being designed to produce half-cores that could be pasted together to form the complete core. A mould made from this pattern would, of course, be poured with the casting on its side in the position indicated at *A*. The first pattern was actually made and used in this way, but it proved unsatisfactory, as the core prints were not large enough to support the core or prevent it from rising in the mould when the casting was being poured.

The second method tried was moulding the pattern on end, as shown at *B*. This method was also a failure, because it was difficult to pass the core down through the mould and enter the print properly in the recess in the bottom of the mould. The end face of the core also proved too small to support the heavy core, so that the latter frequently sunk down into the moulding sand.

A slab core, such as shown at *C*, was then provided to overcome this difficulty. The slab core was rammed up in the mould in both the cope and the drag. This prevented the core from sinking into the moulding sand, but did not eliminate the difficulty experienced in entering the core in the drag. The core prints were next cut down to the size and shape indicated by the dotted lines at *b* in view *D*. "Ram-up" cores *a* were made to fit over the prints. These cores remained in the mould and provided a hard surface on which to set the core. The castings produced from this pattern were found to vary in thickness, due to the failure of the cope flask to line up properly with the drag. This method of moulding was therefore discarded.

The rather unusual method that was finally adopted with success was suggested by the foreman of the foundry. The pattern was made split through the middle and provided with core prints attached to each end, as shown at *E*. These prints were made 6½ in. in diameter, or ½ in. smaller than the diameter of the body core. The core prints were given a ¼-in. taper, as shown in the illustration. The core box for the pattern was made with ends of the shape shown at *F*, particular attention being given to the accurate tapering of the ends of the box. The core prints attached to this pattern were of sufficient size to support the core properly and hold it in place. With the split pattern and the tapering core prints, the moulder was enabled to mould the pattern either on its side or on its end, as desired.



MOULDING A BARREL CASTING.

Establising a Method of Testing for Green Bonded Strength.

BY R. J. DOTY, Vice-President and Works Manager, Sivyer Steel Casting Co., Milwaukee, Wis.

This Paper describes in detail methods which were tried out to accurately determine the relative green bonding strength of steel facing sands. The difficulties encountered were to secure repeatedly accurate uniform ramming of test bar of sand, and a method for pulling or breaking the test bar which would give consistent checks agreeing with the known physical properties. Various shapes of core boxes and methods of ramming were tried out, as well as methods of pulling or breaking the bars.

A method was finally derived, whereby using a core box 16 in. x 3 x 2 1/16 in. in height, producing a core after ramming 16 in. x 2 in. x 1 in. was developed, the bars being broken by a transverse stress. Several transverse and tensile testing methods were tried out, all except one method giving maximum deviation of from 13.75 per cent. to 33.60 per cent. A transverse method was finally decided upon, it giving a maximum deviation 9.35 per cent. and an average deviation of 6.66 per cent.

It was found that by using a volumetric method of measuring the sand used in filling the core box, that as the clay per cent. was increased actually less sand and clay was contained in the bar. This condition was caused by clay films around the sand grains increasing the average fineness of the sand particles. A gravimetric method of measuring the amount of sand to be used in the test bar was finally adopted and the results checked up with practical experience of the shop. By using this check testing of facing strength, uniform facings are produced, and troubles formerly encountered from the use of ununiform facings eliminated.

This Paper is illustrated by the use of tables, charts and photographs.

* Extract of a Paper read before the American Foundrymen's Association.

IRON AND STEEL MARKETS.

Pig-iron.

With general holiday-making prospects imminent in the near future, the outlook in the pig-iron markets indicates a temporary postponement of an expansion of demand sufficient in volume to justify the immediate re-lighting of furnaces, although in some districts preparations for this purpose are already well advanced. Meanwhile, a much more confident tone can be reported in markets generally, while with few exceptions outputs are well absorbed by current requirements. In the Midlands makers are anticipating an early reduction of stocks of iron accumulated of late, but buying is still restricted to immediate necessities, very few forward transactions being recorded, consumers apparently retaining the impression that delayed purchases may be arranged on more advantageous terms. Foundry iron continues in slow demand, consumers of that quality awaiting the return to full activity of the engineering branches, necessarily a slow process after the prolonged suspension of the industry. The outlook for forge iron is, however, regarded as more encouraging, reports that a number of South Staffordshire finishing mills are to be put in operation suggesting an early revival of demand. The Cleveland market has as yet hardly recovered from its recent inaction, while business remains quiet in most sections, having so far failed to realise expectations of an early improvement, which, however, may probably develop within the next few weeks. There has been of late a better inquiry for Cleveland pig from Scotland, but in view of the near approach of the Glasgow Fair holidays, buying on that account has only been on a restricted scale. Business in the export section has been fairly satifactory, the June shipments of pig-iron from the Port of Middlesbrough, including Skinningrove, having turned out better than anticipated, the total amounting to 44,802 tons, as compared with 42,103 tons, an increase of 2,699 tons. The Skinningrove total was 2,922 tons. The coastwise shipments amounted to 9,140 tons, and the colonial and foreign to 32,740 tons. Teeside ironmasters, at a conference on Tuesday afternoon, decided immediately to discontinue fixing quotations for Cleveland pig-iron, so that there is once more an open market, and prices will be a matter of individual negotiation.

The Tees-side market for hematite is again quiet, home demand with the exception of South Wales continuing inactive, and though some shipments are going to Germany, Continental business is quiet, and stocks at furnaces are heavy. The committee of associated makers have fixed 94s. as the price of East Coast mixed numbers, but there is a free market for export, for which quotations are weak and irregular. While 92s. is reported to have been done, about 92s. 6d. to 93s. per ton, f.o.b., represents a general quotation. Similar conditions are marked in the case of West Coast brands, with prices unchanged at 115s. for Bessemer mixed numbers delivered Sheffield or Clyde side.

Finished Iron.

At last week's Birmingham market prospects in the finished iron section were regarded as more favourable than for some time past, and the general tone throughout was distinctly encouraging. Reports of extensive works long idle again resuming operations, and mills restarting in the South Staffordshire area, confirm apparently the more hopeful view entertained of a revival of business, accelerated it may be assumed by the fact that production costs have at length been reduced to levels leaving a profit at the prices now quoted. Makers of bars, and particularly in the common branches, consumers engaged in the nut and bolt and the fencing industries, instead of buying from hand to mouth are anticipating requirements over the next few months. Belgian exporters are again in keen competition in the market by reducing quotations, but home makers are more favourably placed in the matter of deliveries. The mills are fairly well employed, and sellers show an inclination to adopt a rather firmer attitude in respect to prices. Marked bars are based at £13 10s., and inquiry has expended, though the mills could do with more orders. In the West of Scotland the impending holidays have retarded developments for the time being, makers of finished material anticipating at least ten days suspension of business. Prices, however, are somewhat weaker, the Scottish Malleable Iron Makers' Association announcing a reduction of 10s. per ton in the home prices of iron bars. Crown bars are now £10 10s., and best bars £11 per ton, delivered in Glasgow.

Steel.

Slow, but steady recovery is in progress in the steel trade generally, but some time must naturally elapse before anything like normal conditions are restored. It is, however, probable that a moderate volume of business is held over until the completion of the half-yearly stock-taking, general in the trade at this season, when deliveries and production are usually necessarily at a minimum. Notwithstanding these drawbacks, there are unmistakeable signs of a revival of active conditions in sight, though even the most sanguine observers do not anticipate any striking change in the position until at the earliest the autumn season, and then, perhaps, entirely dependent upon the ability of makers to survive the financial strain after the prolonged idleness of the past months. In the semi-product section, business presents a more encouraging aspect than in other branches, the Sheffield market reporting substantial sales of billets consequent upon increased activity at the rolling mills. Local makers are now quoting £7 10s. and £7 15s. for soft basic qualities, although Lincolnshire brands can be bought a shade lower delivered, prices comparing favourably with Continental products. The position in the crucible steel branch is gradually improving, some fairly good orders from the States being reported, while the resumption of the engineering industry may be expected to revive activity in this direction. In the West of Scotland steel-makers have in many cases only sufficient work to keep them going for a short time, and very prompt deliveries can be promised. Steel sheet makers are hopeful of an improvement in conditions in the early future, now that the engineers are back to work, and locomotive and wagon builders are in a better position. Most of the work being done at present is, however, on export account, and the prices obtainable for the heavier gauges are unremunerative on account of the keen English competition.

Scrap.

Demand for all classes of scrap metal is still restricted, although in some localities a certain amount of quiet buying may be noted by consumers when opportunity offers to place business on advantageous terms. This tendency applies more especially in the case of the steel-making district, where more furnaces are going into use, the foundries generally not yet having initiated buying to any great extent. At Middlesbrough the following are approximate current quotations, all delivered works:—Heavy steel scrap, 60s.; heavy cast-iron scrap, machining quality, 80s.; do., ordinary, 75s.; heavy wrought iron piling or bushelling, each, 60s.; special heavy forge, 75s.; steel turnings and cast-iron borings, each, 45s. per ton.

Tinplates.

A noteworthy feature of the week's business in the tinplate market has been the re-introduction of the "pooling" arrangement, the immediate effect being evidenced by a stiffening of prices all round. There has been a moderate volume of inquiries, but not much business has resulted so far, prompt parcels being mostly in demand, which have realised 19s. 6d. to 20s. basis. Makers' quotations for the basis sizes now rule:—Coke tins:—I C 14 by 20, 112 sheets, 108 lbs., 19s. 9d. per box; I C 28 by 20, 112 sheets, 216 lbs., 39s. 6d. per box net, f.o.b. Wales. Terneplates met with a little more inquiry, a moderate business resulting at 18s. 6d. to 18s. 9d. basis for approved specifications, net cash, f.o.b. Wales. Wasters continue in good demand.

Metals.

Copper.—Messrs. Henry Bath & Son, Ltd., in their fortnightly metal report, state:—Great steadiness has ruled throughout the fortnight and the highest and lowest prices paid for standard show a maximum variation of only 7s. 6d. per ton. The principal feature has been the widening of the contango from 5s. to 10s. as the supply of cash warrants improved. Refined copper is still very scarce, and none is yet going into warehouse. In America also there seems a scarcity of copper for home consumption, and it would not be surprising to see prices advance there. There has been an improvement in the price of scrap copper, but only small quantities are now obtainable. Warrants of certain brands of rough copper ex Liverpool warehouses have been obtaining a premium of from 5s. to 7s. 6d. per ton. Current quotations:—*Cash*: Wednesday, £62 10s.; Thursday, £62 7s. 6d.; Friday, £62 18s. 9d.; Monday, £62 17s. 6d.; Tuesday, £62 18s. 9d. *Three Months*: Wednesday, £62 17s. 6d.; Thursday, £62 16s. 3d.; Friday, £63 7s. 6d.; Monday, £63 6s. 3d.; Tuesday, £63 7s. 6d.

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Tin.—The range of values in this market, too, has been extremely small, highest and lowest prices paid during the fortnight only varying to the extent of 17s. 6d. per ton. The tendency is to consider present prices as fairly safe even in view of a probably considerable increase in the visible supply at the end of the month. There is litte doubt that consumption is improving gradually, though the coal strike in America is now beginning to have a bad effect there and that country has bought very little tin recently. She is well supplied, however, for the time being. The demand for tin ore remains unabated, but very little is reaching this country unsold. Current quotations.—*Cash*: Wednesday, £153 10s.; Thursday, £153 17s. 6d.; Friday, £154 5s.; Monday, £154 10s.; Tuesday, £153 10s. *Three Months*: Wednesday, £154 10s.; Thursday, £154 12s. 6d.; Friday, £155; Monday, £155 5s.; Tuesday, £154 5s.

Spelter.—This market has been uninteresting with only a small business and very little movement in prices. Some demand has been seen for early delivery, with the result that the backwardation has returned to 5s. per ton. Latterly fairly good buying of forward spelter has taken place quietly. The demand from galvanisers is showing a tendency to improve, and supplies are not plentiful. Current quotations.—*Ordinary*: Wednesday, £28 2s. 6d.; Thursday, £28 2s. 6d.; Friday, £28 2s. 6d.; Monday, £28 5s.; Tuesday, £28 7s. 6d.

Lead.—Business in soft foreign pig has not reached large dimensions, mainly owing to the scarcity of supplies. Very little June has been obtainable, and the firmness of the near position has induced fair buying of later months, particularly in view of the fact that though the present acute shortage may soon find some relief, there are no signs yet of abundant supplies. The heavy backwardation continues to hamper business. English lead is steady. Current quotations. — *Soft foreign (prompt)*: Wednesday, £25 5s.; Thursday, £25 5s.; Friday, £25 5s.; Monday, £25 5s.; Tuesday, £25 5s.

Trade Talk.

MR. TITEO. AFFLECK, engineer, has removed to the Belmont Engineering Works, Swindon.

F. WILLIS & COMPANY, iron, steel and tinplate merchants, of Gorseinon, near Swansea, have removed to Witton Station, Birmingham.

THE AMERICAN IRON & STEEL INSTITUTE have moved their offices from 61, Broadway, to the Barrett Building, 40, Rector Street, New York.

E. J. HATTERSLEY & COMPANY, steel manufacturers, formerly of 34, Edward Street, have removed to Central Steel Works, Brocco Street, Sheffield.

THE BRITISH INSULATED & HELSBY CABLES, LIMITED, are removing their London office from Lennox House to Surrey House, Embankment, W.C.2.

THE UNITY ENGINEERING & CHEMICAL COMPANY, 94, Market Street, Manchester, have been appointed agents in that city for T. H. and J. Daniels, Limited of Stroud, Glos.

THE ATLAS METAL & ALLOYS COMPANY (1921), LIMITED, formerly of 52, Queen Victoria Street, London, E.C.4, have removed to 1, Central Buildings, Westminster, London, S.W.1.

HALL & PICKLES, LIMITED, Port Street, Manchester, have opened the following new branch offices:—Ipswich, 26, Princes Street; Leicester, 45, London Road; Lincoln, 22, Guildhall Street.

THE RIVER WEAR COMMISSION has arrived at an agreement with T. W. Greenwell & Company, Sunderland, for the construction and leasing of a new graving dock at the South Docks.

THE connection between J. McIntyre & Company, old metal merchants, of 11, York Street, Liverpool, and their London agent, Mr. A. W. Sheffield, of 10, Camomile Street, E.C.3, has been severed.

G. S. PECKHAM & COMPANY, of 4, New Compton Street, W.C., have been appointed sole agents for London and the South of England for the Patent Flexible Belting Company, Eldwick, Bingley, Yorks.

Two men were killed and three injured in an accident which occurred at the steelworks of Alfred Hickman, Ltd., Bilston, when a portion of a steel framework, which was being erected to house a new mill, suddenly collapsed.

MR. C. MARKHAM, chairman of the Park Gate Iron & Steel Company, Limited, has paid out of his own pocket a dividend of 5 per cent. on the shares held by the workpeople employed by the company, although no dividend is being paid by the company.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Barking Shipbreaking Company, Limited, H.M. Dockyard, Gillingham Gate, Gillingham, Kent; the District Waste Company, 81a, King Street, Wednesbury; the Ervedosa Tin Mines, Limited, Stafford House, King William Street, E.C.4; and Wm. Smith, 6, Abbotsford Road, Sparkbrook, Birmingham.

VIVIAN, YOUNGER & BOND, 3, Abchurch Yard, Abchurch Lane, London, E.C.4, have registered the firm as a private limited company, under the style of Vivian, Younger & Bond, Limited, with a capital of £150,000 in fully paid shares of £1 each, the bulk of which will be held by the British Metal Corporation, Limited. The directors are Sir Cecil Lindsay Budd, Mr. Frank Kendall, and Mr. John Cecil Budd, and the two last-named will also act as managers.

MR. I. B. MILNE, owing to ill-health, recently resigned his position as chief of the Metallurgical Department at Hadfields, Limited. As a token of their esteem, his late staff and associates have made him a handsome presentation. Sir Robert Hadfield was unable to attend the presentation, but sent a letter of apology, in which he paid a striking tribute to Mr. Milne's ability and energy during their 34 years' association. Mr. Milne is retaining his seat on the board.

A MEMORIAL to the members of the Institution of Electrical Engineers who gave their lives in the war was unveiled on June 28 in the Institution Building, Savoy Place, by Air Chief-Marshal Sir Hugh Trenchard, assisted by the President of the Institution, Mr. J. S. Highfield, and the senior vice-president, Dr. W. H. Eccles. The memorial takes the form of two bronze tablets in the entrance hall, on which are inscribed the names of those commemorated. Sir Hugh Trenchard stated that more than 2,000 members of the Institution were on active service in the war. Apart from these, most of the remaining members were engaged in the production of electric machinery and power for the supply of munitions. Of those on active service, 162 lost their lives. More than 500 war decorations were awarded to members of the Institution.

REVIEWING the year's work at the fiftieth annual meeting of the National Society of Brass and Metal Mechanics, held at Birmingham recently, the secretary said they had had many trying experiences, particularly in regard to wages movements. First the 12½ per cent. to day-workers and then the 7½ per cent. to piece-workers had to come off; then came the movement for the reduction of the 37s. 6d. war bonus applicable to the members employed in the brass and non-ferrous metal trades of Birmingham and district. This application was met by a move on the part of the Conciliation Board to obtain an agreement with the Birmingham Brassfounders Employers' Association to regulate wages on the cost of living basis. This movement was successful, the outcome being an agreed scheme to regulate wages by a sliding scale of 1d. per hour for every 12½ points, and ½d. per hour for every 6¼ points upwards or downwards, as indicated in the index figure for the cost of living. Certainly they had lost 21s. 6d., as against the 16s. in the engineering trade, but they had the greater satisfaction of an agreed regulated basis for controlling wages.

Output of Iron and Steel in June.

According to the usual monthly return issued by the National Federation of Iron and Steel Manufacturers, the production of pig-iron in June amounted to 369,200 tons, a decline of 38,700 compared with May. The number of furnaces in blast at the end of the month numbered 115, compared with 110 at the end of May. The production included 109,700 tons of hematite, 139,200 tons basic, 78,900 tons foundry, and 18,400 tons forge pig-iron. The production of steel ingots and castings also declined in June to 400,200 tons, compared with 462,300 tons in May.

The following table shows the average monthly production of pig-iron and steel ingots and castings in 1913, 1920 and 1921, and in each month since June, 1921:—

Averame Monthly.		Pig-iron. Tons.	Steel Ingots and Castings. Tons.
1913	....	855,000	638,600
1920	....	669,500	755,600
1921	.....	217,600	302,200
1921	June	800	2,700
	July	10,200	117,200
	August	94,200	434,100
	September ...	158,300	429,300
	October	235,500	405,400
	November ..	271,800	443,800
	December ...	275,000	381,000
1922	January	288,000	327,500
	February ..	300,100	418,800
	March	389,800	549,400
	April	394,300	404,200
	May	407,900	462,300
	June	369,200	400,200

...TRADE...
SIROCCO
...MARK...

CENTRIFUGAL FANS

For Supplying Blast to

Cupolas and Forge Fires.

Made in a large variety of sizes and suitable for pressures up to 30-in. W.G. The Fans have cast iron casings and the belt driven type are fitted with Ball Bearings.

Send for particulars to :—

DAVIDSON & CO., LTD.,
Sirocco Engineering Works, Belfast.

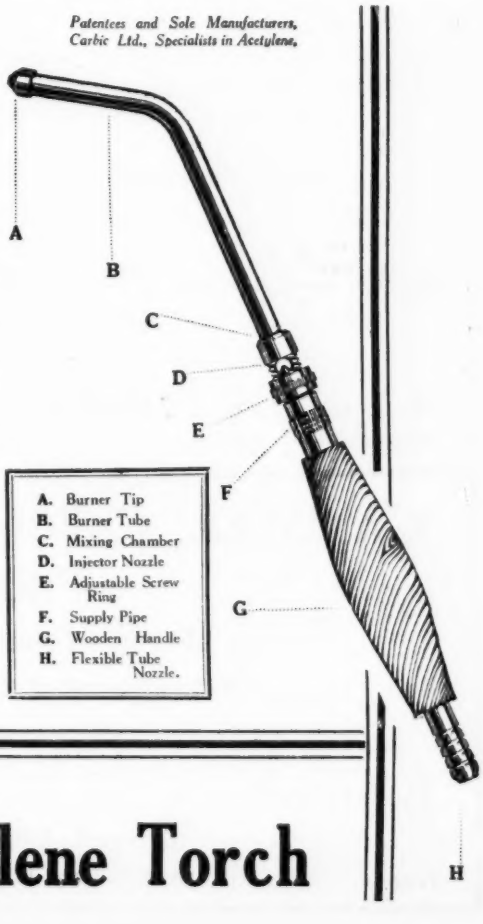
3 useful tools in One

Patentees and Sole Manufacturers, Carbic Ltd., Specialists in Acetylene.

HERE is a new and inexpensive 3-in-1 tool that will quickly save its first cost and thereafter give sheer profit. This is how you use the Carbic Adjustable Acetylene Torch. On a large and costly sand-mould, for example : examine deep awkward corners with the torch set to lighting position ; without moving the torch move adjusting ring over the air ports to give a clear hot bunsen flame and "dry" the mould—then set the ring to give a smoky soot-laden flame which rapidly deposits an even layer of finely divided 100% pure carbon. A boy can use this new torch efficiently.

The outfit includes a Portable Acetylene Generator and Hose. Made by the makers of Carbic portable oxy-acetylene cutting and welding plants. Send a postcard for the illustrated and priced folder giving the full description.

CARBIC LIMITED
Specialists in Acetylene,
51, Holborn Viaduct, London, E.C.1.
BRANCHES : Liverpool, Newcastle-on-Tyne, Glasgow, Southampton, Leeds, Cardiff, where stocks are always available.



A. Burner Tip
B. Burner Tube
C. Mixing Chamber
D. Injector Nozzle
E. Adjustable Screw Ring
F. Supply Pipe
G. Wooden Handle
H. Flexible Tube Nozzle.

The CARBIC

Adjustable Acetylene Torch

Company News.

Birmingham Electric Castings, Limited. — Capital £2,000. Directors: F. Shutt, W. Shutt, and D. Pitt. Registered office: Kings Road, Hay Mills, Birmingham.

Vickers, Limited.—Profit, £708,103; brought forward, £991,639; preference dividend, £395,707; ordinary dividend, 5 per cent. per annum, less tax; carried forward, £872,994.

Chapman & Perry, Limited.—Capital £1,000. Iron, steel and tinplate merchants, etc. Directors: D. R. Chapman and C. S. Perry. Registered office: 32, Nassau Street, Dublin.

Burn Brothers (London), Limited.—Capital £50,000 in £1 shares (25,000 ordinary and 25,000 5 per cent. cumulative preference). Engineers. Registered office: 3, Blackfriars Road, S.E.

Chambers & Hammond, Limited.—Capital £15,000 in £1 shares. Chemical engineers. Directors: J. T. Wilman, E. V. Chambers, S. Wilman, and T. C. Hammond. Registered office: Lightcliffe.

Crompton & Company, Limited.—Net profit, £35,828; brought forward, £18,370; preference dividend, 7 per cent. for year; ordinary dividend, 5 per cent.; reserved for future taxation, £10,000; carried forward, £18,084.

Gibbons (Dudley), Limited.—Interim preference and ordinary dividends, 7 per cent. per annum, free of tax.

Northumberland Shipbuilding Company, Limited.—Dividend on cumulative participating preference shares deferred.

Maitland & Company (Kelvinhaugh), Limited. — Capital £20,000. Sheet metal workers, iron and steel founders, general engineers, etc. Directors: D. Maitland, T. A. Watt, D. M. Macfarlane, D. McGibbon, and W. Munro. Registered office: 222, Kelvinhaugh Street, Glasgow.

Vivian Younger & Bond, Limited.—Capital £150,000 in £1 shares. Metal merchants. Directors: Sir Cecil L. Budd (director British Metal Corporation, Limited, and Eastern Smelting Company, Limited), chairman; F. Kendall, and J. C. Budd. Secretary: F. C. Bell. Registered office: 3, Abchurch Yard, E.C.4.

Agricultural & General Engineers, Limited.—Taxation charges, £64,621; head office administration and selling expenses, £86,940; interest on sums advanced, £31,344; loss for year, £216,961; preference dividend deferred; arrears of dividend, less tax, to March 31, on 8 per cent. and 6 per cent. cumulative preference, £43,185.

Personal.

THE LATE Mr. J. Marshall, of Marshall, Sons, & Company, Limited, engineers, Gainsborough, left £178,485, including net personalty £171,685.

THE LATE Mr. H. E. Hollis, of Glasgow, a director of Arthur Balfour & Company, Limited, Dannemora Steelworks, Sheffield, left personal estate valued at £12,682.

MR. M. V. WARD has resigned his directorship of I. S. M., Limited, iron and steel merchants, of 61, Goswell Road, London, E.C.1, and is no longer connected with that company.

MR. T. COVERDALE, assistant train-master (freight section), Middlesbrough, who entered the service of the North-Eastern Railway Company at West Hartlepool, in the early part of 1871, has retired.

MR. ADAMS, of Rotherham, after 30 years service as the manager at the works of William Oxley & Company, Limited, Parkgate, retired on June 30. He has been the recipient of a presentation from the officials and men.

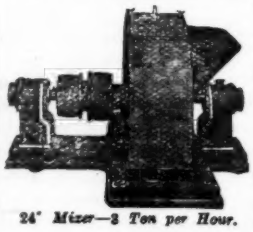
VICE-ADMIRAL SIR GEORGE GOODWIN, the late Engineer-in-Chief of the Navy, has been elected to a seat on the board of directors of Richardsons, Westgarth & Company, Limited, of Hartlepool, Middlesbrough and Sunderland.

MR. D. W. TURNER, late general manager and director of the Midland Railway, Carriage and Wagon Company, Limited, who is also associated with Cammell, Laird & Company, Limited, has been elected chairman of the Wellington Tube Works, Limited, Great Bridge, Staffs.

MR. D. BEVAN, Hendre, Llangennech, has died at the age of 61 years. The deceased gentleman was brought up in the tinplate industry under the late Mr. William Williams, M.P., at Morriston, and when that gentleman gave up his interests in the Morlais Tinplate Works, Llangennech, Mr. Bevan formed the present company. He acted for many years as manager, but he relinquished his duties in favour of his brother, Mr. T. Bevan. Afterwards the deceased gentleman became interested in the Grovesend Steel Works, as well as the Raventon Works (Glanamman) and the Hendy Tinworks at Pontardulais.

FOUNDRY REQUISITES.
Try our REFRACTORIES.
Ganisteror Silica Bricks and Blocks (any shape or size). Sands, Cements, Ganister.—*Let us have your enquiries.*
THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.,
Normanby Brickworks Normanby, Eston Yorks.

SUPERIOR SILICA BRICKS
FINE SILICA CEMENT.
TRADE MARK — R. DINAS.
H. & H. E. SMART, KIDWELLY.

THE INVINCIBLE SAND MIXER.

Fitted with Patent Roller Bearings. Renewable Reels, Grinds Mixes, Screens & Prepares.
OLD AND NEW FOUNDRY SANDS AT LOWEST COST.
Saves Labour—Reduces Foundry Costs.
Made in Three Sizes—1 3 and 6 Tons per hour capacity.
24" *Mixer—3 Ton per Hour.* USED IN PRINCIPAL FOUNDRIES.
PRICES ON APPLICATION.
C. E. V. HALL, 26, Paradise Sq., Sheffield.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

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Pig-Iron Manufacturers.

Suitable for all

GENERAL FOUNDRY PURPOSES.

Brands: STAVELEY and RINGWOOD.

The Services of our expert Metallurgical Staff are at Buyers' disposal.
We are prepared to advise suitable mixtures, for all foundry purposes.

CAST IRON PIPES

of all sizes for Water, Gas, Steam and Hydraulic Pressure.

HEAVY CASTINGS OF ALL DESCRIPTIONS.

Chemical Manufacturers:

Aniline Oil,
Aniline Salt,
Naphthaline Balls,
Naphthaline Tablets,
Hot Pressed Naphthalene,
Naphthalene Flakes,
Naphthalene Powder,
Cresylic Acid,
Crude Carbolic Acid,
Creosote Oil,
Green Oil, Pitch,
Sulphate of Ammonia,
Muriate of Ammonia,
B.O.V. & R.O.V.,
Oleum (all strengths),
Pure Sulphuric Acid,
Nitric Acid,
Disinfectant Powder.

'STAVEHO" For Making Cement Work Waterproof.

PLEASE WRITE FOR PRICES.

WEEKLY PRICE CURRENT.

COPPER.

	£	s	d.
Standard cash	62	18	9
Three months	63	7	6
Electrolytic	70	5	0
Tough	66	5	0
Best selected	66	10	0
Sheets	94	0	0
India	83	10	0
Wire bars	71	15	0
Do. Aug.	71	12	6
Do. Sept.	71	12	6
Ingot bars	71	10	0
H.C. wire rods	75	15	0
Off. aver. cash, June	62	0	11 1/16
Do. 3 mths., June	62	8	5 1/16
Do. Settlement June	62	1	0
Do. Electro, June	70	1	2
Do. B.S., June ..	67	12	2
Aver. spot price, copper, June ..	61	19	11
Do. Electro, June	70	15	8

Solid drawn tubes .. 13½d.
Brazed tubes .. .. 13d.
Wire .. .. .. 10½d.
Yellow metal rods .. 6½d.
Do. 4x4 Squares .. 8½d.
Do. 4x3 Sheets .. 9½d.

BRASS.

Solid drawn tubes .. 11½d.
Brazed tubes .. .. 13d.
Rods, drawn .. .. 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. .. 9½d.
Wire .. .. .. 9½d.
Rolled metal .. 9½d.

TIN.

Standard cash ..	153	10	0
Three Months ..	154	5	0
English	153	10	0
Bars	155	10	0
Chinese	152	0	0
Straits	155	0	0
Australian	156	10	0
Eastern	157	10	0
Banca	153	10	0
Off. aver., cash, June	152	12	3½
Do. 3 mths., June	153	14	5½
Do. Sttlment. June	152	12	3½
Aver. spot, June ..	152	11	1

SPELTER.

Ordinary	28	7	6
Remelted	25	15	0
Hard	20	0	0
Electro 99.9	32	15	0
English	28	15	0
India	22	5	0
Prime Western ..	28	10	0
Zinc dust	40	0	0
Zinc ashes	4	15	0
Off. aver., June ..	27	16	1 3/4
Aver., spot, June ..	27	17	11½

LEAD.

Soft foreign ppt ..	25	5	0
English	25	15	0
Off. average, June	24	3	2 1/4
Average spot, June	24	14	2

ZINC SHEETS.

Zinc sheets, English	36	0	0
Do. V.M. ex. whf.	36	0	0
Rods	41	0	0
Dutch	36	0	0
Boiler plates	34	0	0
Battery plates ..	34	10	0

ANTIMONY.

English regulus ..	25	15	0
Special brands ..	32	10	0
Chinese	24	10	0
Crude	14	10	0

QUICKSILVER.

Quicksilver 11 10 0 to 12 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 13 2 6
75% 23 5 0

Ferro-vanadium—
35/40% 18/3 to 18/6 lb. va.

Ferro-molybdenum—
70/75% 6/- to 6/6 lb. mo.

Ferro-titanium—
23/25%, carbonless 1/2 lb.

Ferro-phosphorus, 20/23%, £20

Ferro-tungsten—
80/85%, carbon free 1/5 lb.

Tungsten metal powder—
98/99% .. .. 1/8 lb.

Ferro-chrome—
4/6% car. £24
6/8% car. £23 10
8/10% car. .. £23 5

Ferro-chrome—
Max. 2% car. .. £68
Max. 1% car. .. £78
Max. 0.70% car. .. £94
67/70%, carbonless 1/9½ lb.

Nickel—99%, cubes or pellets £160

Cobalt metal—98/99% 10/6 lb.

Aluminium—98/99% £100

Metallic Chromium—
96/98% .. .. 5/- lb

Ferro-manganese (net)—
76/80%, loose .. £15
76/80%, packed .. £16
76/80%, export .. £14 10

Metallic manganese—
94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ½ in. 3d. lb.
Flats under 1 in. by ½ in. to ½ in. by ½ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. .. £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces .. .. 3d.
Turnings and swarf .. 1d
Per lb. net, d/d steel makers' works.

SCRAP.

South Wales—	£	s.	d.
Heavy Steel	3	10	0
Bundled steel & shearings	2	18	0
Mixed iron & steel	2	17	6
Heavy cast iron	3	10	0
Good machinery for foundries	4	0	0

3	15	0	
3	8	6	
3	5	0	
4	0	0	

Cleveland—			
Heavy steel	3	0	0
Steel turnings	2	5	0
Cast-iron borings	2	5	0
Heavy forge	3	7	6
Bushelled scrap	3	0	0
Cast-iron scrap	3	15	0

Lancashire—			
Cast iron scrap	4	5	0
Heavy wrought	3	5	0
Steel turnings	2	2	6

London—	£	s.	d.
Copper (clean)	54	10	0
Brass (clean)	29	0	0
Lead (less usual draft)	20	10	0
Tea lead	18	10	0
Zinc	16	0	0
New aluminium cuttings	65	0	0
Braziery copper	44	10	0
Gun metal	39	0	0
Hollow pewter	120	0	0
Shaped black pewter	70	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast—
Foundry No. 1 .. 95/-
Foundry No. 3 .. 90/-
Forge No. 4 .. .. 85/-
Mottled 80/-
Hematite No. 1 .. 95/-
Hematite M/Nos. .. 94/-

Midlands—
Staffs. common .. —
„ part-mine forge —
„ „ foundry —
„ Cold blast .. 240/-
„ basic .. .. —

Northants forge 70/- to 72/6
„ foundry No. 3 77/6 „ 80/-
„ basic 82/6

Derbyshire forge .. 75/-
„ foundry No. 3 82/6
„ basic .. 80/-

Scotland—
Foundry No. 1 .. 100/-
„ No. 3 .. 95/-
Hematite M/Nos. .. 110/-

Sheffield (d/d district)—
Derby forge 82/6
„ foundry No. 3 86/6
„ basic .. .. —
Lincs. forge 86/6
„ foundry No. 3 86/6
„ basic 86/6
E.C. hematite .. 107/6
W.C. hematite .. 115/-
All d/d in the district.

Lancashire (d/d eq. Man.) —
Derby forge .. .. —
„ foundry No. 3 92/6
Northants foundry No. 3 .. .. —
Cleveland foundry No. 3 .. .. —
Staffs. foundry No. 3 —
Lincs. forge .. .. —
„ foundry No. 3 —
Summerlee foundry .. 112/-
Glengarnock foundry 114/6
Gartsherrie foundry 114/6
Monkland foundry .. 112/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (crown)	£10	10 to £12	
Angles ..	£11 to £12	10	0
Tees to 3 united ins.	£11 10 to	13	0
Nut and bolt ..	10	0	0
Hoops	14	0	0
Marked bars (Staffs.) ..	13	10	0
Gas strip ..	11	7	6
Bolts and nuts, ¾ in. × 4 in.	22	0	0

Steel—			
Ship plates ..	10	0	0
Boiler plates ..	13	10	0
Chequer plates	10	10	0
Angles	9	10	0
Tees	10	10	0
Channels ..	8	15	0
Joists	10	0	0
Rounds & squares 3-in. to 5½in. ..	10	10	0
Rounds, under 3in. to ¾in. ..	9	10	0
Flats, over 5in. wide and up ..	10	0	0
Flats 5in. to 1¼in.	8	10	0

	£	s.	d.
Rails, heavy ..	9	10	0
Fishplates ..	14	10	0
Hoops	12	0	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	15	15	0
Galv. fencing wire, 8 g. plain ..	16	0	0
Rivets, ¾ in. dia	15	0	0
Billets, soft	7 5 0 to	7	10 0
Billets, hard ..	8	0	0
Sheet bars	7 7 6 to	7	15 0

PHOSPHOR BRONZE.

	Per lb basis.	
Strip	1	3
Sheet	1	3½
Wire	1	3½
Rods	1	2½
Tubes	1	6
Castings	1	1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled—	
To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6½ to 2/0½
To 18 in. wide	1/7½ to 2/1½
To 21 in. wide	1/8½ to 2/2½
To 25 in. wide	1/9½ to 2/3½
Ingots for spoons and forks ..	11d. to 1/5
Ingots rolled to spoon size ..	1/2 to 1/8

Wire round—
3/0 to 10. G. .. 1/8½ to 2/3½
with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	27.82
No. 2 foundry Valley ..	24.00
No. 2 foundry, Birm. ..	18.00
Basic	26.96
Bessemer	26.96
Malleable	26.46
Grey forge	25.46
Ferro-manganese 80 % delivered	70.82
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	35.00
Wire rods	40.00

	Cents.
Iron bars, Phila. ..	1.96
Steel bars	1.70
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel ..	1.70
Skelp, sheared steel ..	1.70
Steel hoops	2.40
Sheets, black, No. 28 ..	3.15
Sheets, galv., No. 28 ..	4.15
Sheets, blue an'l'd, 9&10	2.40
Wire nails	2.40
Plain wire	2.25
Barbed wire, galv. ..	3.05
Tinplate, 100-lb. box ..	$4.75

COKE (at ovens).

Welsh foundry	32/6
„ furnace	22/6
Durham & North. foundry	28/-
„ furnace ..	23/6
Other Districts, foundry	27/6
„ furnace	22/6

SWEDISH IRON.

Bars, hammered basis sizes Basis price £24 to £25

	£ s. d.
Rolled Ordinary— Assortment ..	17 0 0 to 17 10 0
Nail Rods— Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £8 to £8 15 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents here.

TUBES.

Up to and incl. 6 in.

Gas	..	55%
Water	..	50%
Steam	..	45%

Tube prices are now free.

TINPLATES.

I.C.Cokes,	20×14, box	19/9
„	28×20, „	39/6
„	20×10, „	28/3
„	18¾×14, „	20/-
I.X.	„	45/-
I.X.X.	„	51/-
F.C.B.Y.	21×13⅝ „	37/6
C.V.B.G.	16½×15, „	34/9
I.C.W.	20×14, „	17/9
„	28×20, „	36/-
„	20×10, „	24/9
„	18¾×14, „	18/3
Ternepiates,	28×20. „	37/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
July 5	62	10	0	No change
„ 6	62	7	6	dec. 2/6
„ 7	62	18	9	inc. 11/3
„ 10	62	17	6	dec. 1/3
„ 11	62	18	9	inc. 1/3

Electrolytic Copper.

July 5	70	0	0	No change
„ 6	70	0	0	„
„ 7	70	0	0	„
„ 10	70	5	0	inc. 5/-
„ 11	70	5	0	No change

Standard Tin (cash).

July 5	153	10	0	dec. 7/6
„ 6	153	17	6	inc. 7/6
„ 7	154	5	0	„ 7/6
„ 10	154	10	0	„ 5/-
„ 11	153	10	0	dec. 20/-

Tin (English ingots)

July 5	153	10	0	dec. 20/-
„ 6	154	0	0	inc. 10/-
„ 7	154	0	0	No chang
„ 10	154	10	0	inc. 10/-
„ 11	153	10	0	dec. 20/-

Zinc Sheets (English)

July 5	36	0	0	No change
„ 6	36	0	0	„
„ 7	36	0	0	„
„ 10	36	0	0	„
„ 11	36	0	0	„

Spelter (ordinary).

July 5	28	2	6	inc. 2/6
„ 6	28	2	6	No change
„ 7	28	2	6	„
„ 10	28	5	0	inc. 2/6
„ 11	28	7	6	„ 2/6

Lead (English)

July 5	25	15	0	No change
„ 6	25	15	0	„
„ 7	25	15	0	„
„ 10	25	15	0	„
„ 11	25	15	0	„

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ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:

CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

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Cogan Street and 1-3-5-7 Spruce Street, HULL,
— FOR —
FOUNDRY SUPPLIES
Price Lists on Application.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.
REGISTERED TRADE MARK
1, HONG KONG ROAD, SHANGHAI.
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
FOUNDRY COKE
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.
WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

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ADVERTISER, Age 39, seeks position as Non-ferrous FOUNDRY MANAGER. Twenty-five years' practical experience. Thorough knowledge of up-to-date plant and practice. Unimpeachable references. Address, in first instance, Box 212, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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WANTED, working charge hand for small Iron Foundry. Must be thoroughly conversant with machine—produced light-grey iron castings. State experience, and salary required.—Box 210, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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FOR SALE.

Ingersoll Sergeant Direct Line Steam-Driven Air Compressor, 14½ in. air cyl., 14 in. steam, 14 in. stroke, capacity 384 cubic ft. free air per minute. Horizontal Engine, trunk slide pattern, 18 in. cyl., 36 in. stroke, by E. R. and F. Turner. Two Cross Compound Horizontal Drop Valve Engines, 12½ in. and 20 in. cyls., 26 in. stroke, by Robey & Co., Ltd. 75 K.W. Generating Set, Compound "Bellis" Engine direct coupled to Mather & Platt Generator, 460 volts, 163 amps., 440 revs. No. 9 Pulsometer Pump, 7 in. suction, with foot valve and strainer. Vertical Three-Throw Geared and Belt-Driven Hydraulic Pumps, rams 2½ in. diam., 6 in. stroke, by H. Berry & Co., Ltd. Single Standard Hydraulic Forging Press, 10 in. ram, about 14 in. stroke, working pressure 1,500 lbs., by H. Berry & Co., Ltd. Two Horizontal Hydraulic Breaking Presses, ram 12 in. diam., 6 in. stroke, working pressure 1 ton per sq. in., by H. Berry & Co., Ltd. Horizontal Boring Machine, by Noble & Lund, hole in spindle 3 in., T slotted table 3 ft. 6 in. x 3 ft. 6 in., bed 7 ft. 6 in. long. 36 in. Colburn Vertical Boring and Turning Mill, with 30 in. chuck-plate.

Catalogue of Stock Machinery, 5-6,000 Lots Free on Application. Inspection Invited

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Eight very good second-hand Single-ended, Four-furnace MARINE BOILERS, 10 ft. 2 in. diam. by 16 ft. 3 in. long, with all steam and furnace fittings, re-insureable at a working pressure of 145 lbs. per sq. inch. For details, price and copy of Insurance Co.'s report, apply—

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ONE new 2-ton Geared Ladle for sale; price £20.—For further particulars apply to TURNER, ATHERTON & COMPANY, LIMITED, Denton.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

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4 FT. brand new Foundry Sand Mixer, two Steel Tubes, 6 ft. x 3 ft. diameter, make excellent Cupola. Sirocco 8-in. Belt Driven Fan, 7½-h.p. Campbell Oil Engine, small Planing Machine by Kershaw, 30-h.p. Hornsby Gas Engine, practically new. Low prices.

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SOMETHING NEW.—To Safe and Strong-Room Door Manufacturers. A Material that will resist burning by Oxy-Acetylene and Electricity. All interested can test same conditionally on expenses being defrayed. All correspondence dealt with in strict rotation. Correspondence only in first instance, to F. P., c/o 462, Commercial Road, Portsmouth, Hants.

A FULLY-EQUIPPED IRON FOUNDRY, with good connection, capable of turning out 15 to 20 tons per week. To be let or sold. For further particulars, write Box 214, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to fifteen cwt. Complete machines built throughout to specification, singly or in quantity. Designing and patterns a speciality.—C. S. PRATFIELD, LIMITED, Market Rasen.

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Expert metallurgical, analytical and consulting service given by old-established firm of metallurgical chemists (chemical analysis, general foundry work, mixtures, research, etc). Write at once for lists and details.—BEECROFT & PARTNERS, LIMITED, Valley Road, Chesterfield.

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FOUNDRY Plant and machinery of all kinds, for resale. Prompt cash paid, or I will supply suitable machines for your work, taking your idle plant in part payment.

A LARGE STOCK of Foundry Plant, also loose tools, may always be seen at my works here.

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